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WORLD PETROLEUM

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IRISH REFINING MONOPOLY

OIL CONCESSIONS IN ALBANIA

U. S. EXPORT POSITION IMPROVING

AQUILA REFINERY IN ITALY

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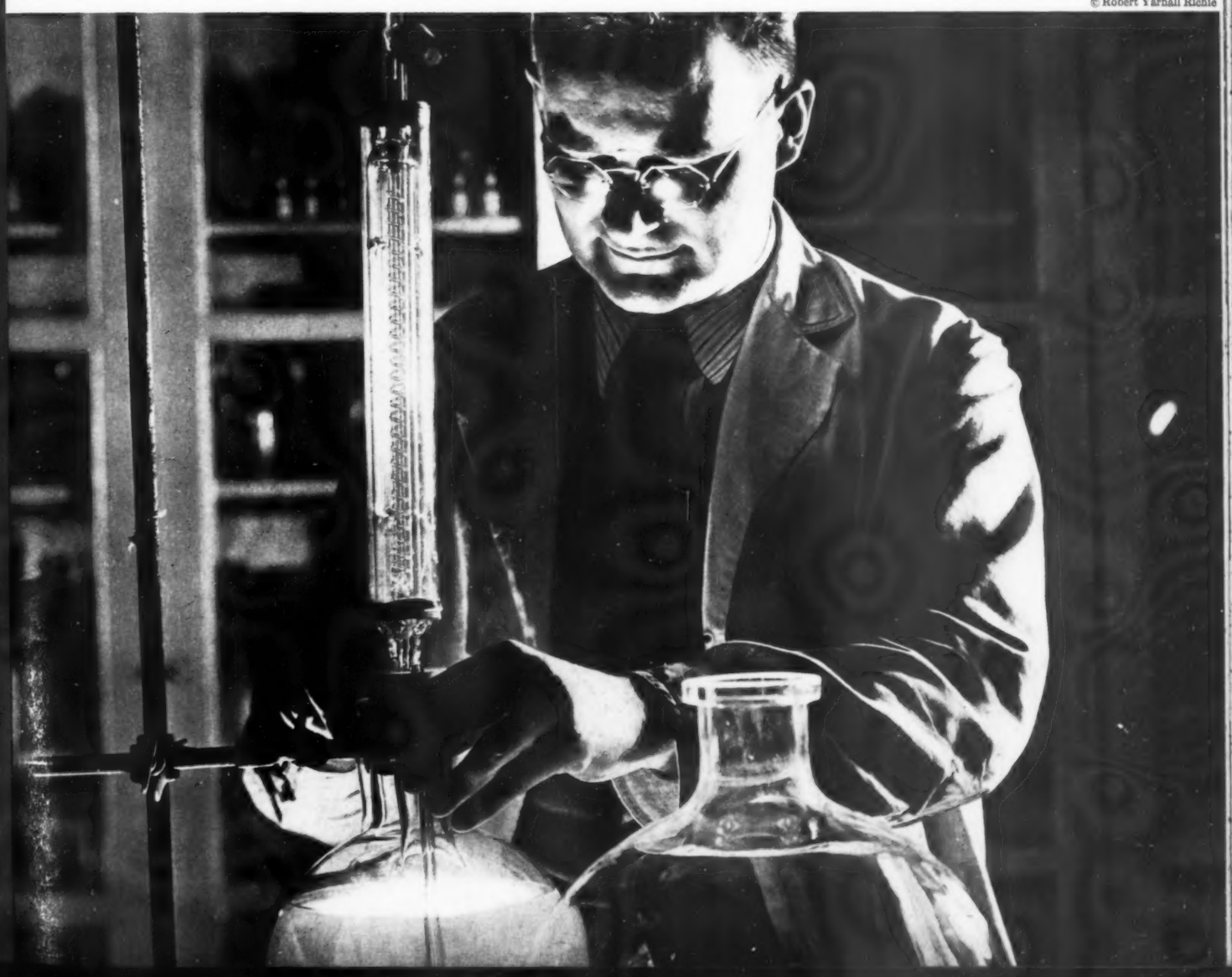

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EDITORIAL

SOFT PEDALLING THE CIO DRIVE ON OIL

UNIONIZATION of a million oil industry workers under the banner of the Committee on Industrial Organization was announced with a great blare of trumpets early in the year as the objective of an immediate campaign to be undertaken by that organization. Enrollment of this notable addition to John L. Lewis's militant army of labor was to start at the beginning of April and it was boldly stated that before the month was over the oil industry would be fully under the contol of the Lewis organization through the International Oil Well, Gas and Refinery Workers Association.

For some reason not made known the backers of this movement have changed their tune most remarkably and are proceeding with their efforts in a manner not at all in the usual Lewis tempo. A factor possibly contributing to their changed attitude was the outspoken declaration of Governor Allred of Texas that the sit-down strike, favorite Lewis weapon for demoralizing industry, would not be tolerated in Texas, and that he did not propose to have the state turned into another Michigan. Unlike Coalman Lewis, who does not hesitate to issue orders to mere Governors and even commands the President of the United States to back up his demands, Leader Fremming of the C.I.O. oil industry subsidiary replied to Governor Allred with most purring words. He was pained that the Governor should have been misled into believing for one moment that the group he represented would countenance the forcible seizure of oil company property. Their only mission was to spread peace and good will, and incidentally of course to raise the downtrodden oil workers to the high economic level of Mr. Lewis's organized coal miners in the eastern states.

In all likelihood the C.I.O. agitators have been advised by men familiar with the temper and ideas of the rank and file of oil field workers that it will be inadvisable to attempt the coercive methods applied to factory operatives in Michigan and Ohio. The average oil field worker is a real he-man, a prideful American, not easily intimidated. He knows that although the price of crude is much below what it was ten years ago he is drawing peak wages and that his pay is well above that of workers in most other industries. Employment is constant and he has no desire to disturb present conditions. He is more than a trifle suspicious of coal men offering to organize the oil industry in view of the efforts of coal country representatives to hamper the sale of oil products by imposing penalty taxes. He feels quite capable of looking out for himself and can see no reason for paying dues to support a crowd of professional non-workers. In deference to this attitude it is reported that the C.I.O. organizers are waiving dues and initiation fees in the effort to get a large paper membership and make an impressive showing. This, however, tends to confirm the belief rather widely held in the oil fields that the movement in which they are invited to join is a political racket conducted for the benefit and aggrandizement of the men directing it.

ANOTHER objection frequently voiced against the scheme of one big union of all oil workers is that it takes in entirely too much ground. According to the plans announced by the C.I.O. group early in the year the bulk of the million membership which they proposed to enroll was to consist of service station employes, with refinery, pipe line and field workers constituting about 25 percent of the whole. Since more and more service station men are becoming individual proprietors rather than company employes they may feel no great interest in becoming unionized, but if the expectations of the labor organizers were realized it is difficult to envision the field workers, who are the most independent group in the industry, submitting to having their relations with employers dictated by service station men.

While the drive to herd the workers of the oil industry into the Lewis corral is under way it is being conducted much more quietly and with less aggressiveness than early announcements would have led one to expect. So far as production and pipeline workers are concerned it seems to be lagging. Such progress as has been made to date seems to be among employes of the smaller and less substantial refineries whose proprietors find it difficult to maintain the wage scale established by the large companies. Nearly all the larger refineries have labor organizations of one sort or another. Some of these may decide to don the Lewis badge but many of them undoubtedly will prefer to maintain their independence or their present affiliations.

AMONG the oil companies the disposition appears to be to let employes follow their own inclinations in deciding upon the form of organization they prefer. Unionization prevails today throughout the greater part of the oil industry. The only question presented to workers by the C.I.O. drive is whether they prefer a union operated by and for oil men or a mass labor organization directed by men who have made labor agitation into a profitable profession. No other industry can point to a better record than petroleum, either in the rate of wages paid or in freedom from industrial strife. It is difficult to see how this record can be improved by submitting the relations between employe and employer to the domination of outsiders whose objective, as indicated by the conduct they have sponsored elsewhere, is to create a bitter class animosity as a stepping stone to political power for themselves.

WHEN WE DRILL THE OCEAN FLOOR!

BOTH technical and legal problems are likely to be raised by the future development of submarine drilling. The latter may prove to be more difficult of solution than the former. One such legal issue was brought up in California some months ago by the efforts of the state authorities to prevent the holders of leases near the shore line from tapping sands that lay beneath the waves of the Pacific.

In these particular instances the oil was reached from points inshore by directional drilling. It is conceivable, in fact probable, however, that oil may be found at much greater distances offshore. On the California coast wells have been drilled from piers extending a thousand feet or more into the ocean and only a few months ago a paper presented before a group of technical men discussed the probable extent and location of salt domes beneath the Gulf of Mexico.

The potentialities of the situation have not escaped the attention of national legislators. A bill was introduced into Congress within the past few weeks declaring that all petroleum deposits below coastal waters, from low tide level to the three miles limit, shall be the property of the nation. Should such a measure be enacted it might raise some questions of jurisdiction, particularly in the case of Texas which was an independent nation before it became a part of the American Union and might very well contend that it never had assigned control of the waters adjoining its coast. Since Texas has a shore line of a thousand miles more or less in the area where the drilling of under water wells would seem to offer the greatest promise the question of authority may become a practical rather than merely an academic issue.

Most of the submarine drilling that has taken place thus far has been in shallow and land locked waters where questions of ownership and control have been relatively simple. With the improvement in drilling technique and equipment that is going steadily on, however, means of operating at greater depths will be developed. If oil exists a few hundred feet or a few miles from shore there is no reason why it may not exist under certain conditions many miles out. As supplies from present sources begin to lag or as demand becomes greater such deposits may assume great value and the question as to who shall own and work them may become a live and burning issue. Certainly the nations owning the land that lies nearest them will insist upon a revision of the existing interpretation of international law confining their authority to a distance of three miles from shore.

Speculation on this subject may seem fanciful at this moment. There is nothing impractical, however, in suggesting that we may see in the future producing wells and even important fields located on favorable structures far from land. It is less of a strain on the imagination today to envision such a development than it would have been for the pioneers of the oil industry to believe in the possibility of ten thousand foot wells.

IRISH MARKETERS' DILEMMA

DISTRIBUTORS of petroleum products in the Irish Free State are faced with an unusual problem by the decision of the Dublin government to establish a monopoly of refining. The greater part of the marketing business is in the hands of three companies. By reaching an agreement among themselves these companies probably could have made arrangements for the construction and operation of a jointly owned refinery. Instead of following that course the two larger of the group conducted a survey of the field as a result of which they issued a statement declaring their opinion that the maintenance of a refinery for the sole purpose of supplying the Free State market would be uneconomic and unsatisfactory.

The basis stated for this conclusion was that the demand for the various products of refining in southern Ireland was not in such balance that a refinery could supply them in the required proportions. Likewise, the report pointed out, a blended crude was needed for refining and no one source could supply a wholly satisfactory crude. For these reasons the companies declined to undertake the construction of a refinery themselves and advised against it on the ground of public interest.

The government, however, was fully committed to the idea of a domestic refinery and entered into an agreement with outside interests not previously identified with the Irish oil industry to build a plant. The established marketers were left free to continue the sale of products but under compulsion to purchase these from the refining monopoly. This they are unwilling to do and as an alternative are considering withdrawal from the country.

The position of the marketing companies is not difficult to understand. They sell trade marked brands of motor fuel and lubricants. Through extensive advertising campaigns they have built up a demand for these products based on the claim that their manufacture is directed with special care to bring out certain qualities and characteristics. If they sell under these established brands products whose specifications they do not control the claims made through their advertising become ridiculous. If they abandon their trade names and sell products of unspecified character their customers in other countries are likely to conclude that the brand names mean very little after all. While the companies naturally are loath to abandon established market territory they evidently feel that it would be preferable to withdraw entirely from the Irish Free State rather than be put in the untenable position indicated.

IRISH REFINING MONOPOLY

May Lead to British Marketing Conflict

Withdrawal of Major Companies From Irish Free State is Threatened — Reprisals on Thames Haven May Cause New Group to Enter English Market

CLOUDS are gathering over one quarter of the heretofore placid British oil scene. Mutterings of thunder emanating now and then from this direction indicate the possibility of a storm of more or less serious proportions. The situation is bringing about a new alignment of interests and may lead to the first serious attempt in years to challenge the position of the major oil companies in the markets of the United Kingdom. When Chairman T. C. J. Burgess of London and Thames Haven Oil Wharves Ltd. referred, in addressing his shareholders recently, to "fighting a battle" in the oil trade it is not to be assumed that he was uttering a mere rhetorical phrase. Mr. Burgess is not the sort of individual to run away from a contest. He has identified himself prominently with the project for establishment of a refining monopoly in the Irish Free State as a result of which the large distributors are threatening to withdraw from that territory. Whether as a result of this or because of the completion of other plans some of the companies that have been large users of London and Thames Haven facilities are discontinuing their relations with that establishment. There is a definite hint in Mr. Burgess's recent statements that he and his associates may enter the distributing field in England.

While this latter suggestion is mere speculation as to future possibilities it is no exaggeration to say that at the present time relations between the so-called national companies—Shell, Anglo-Iranian and Anglo-American—and London and Thames Haven are decidedly strained and that these companies view with great disfavor some of the activities of Mr. Burgess and the men with whom he has associated himself whom they regard as potential trouble makers. The present situation had its genesis in 1935 when the government of the Irish Free State became infected by the internal refining virus. The Free State authorities gave a tariff preference of 2d. per gallon, on a total duty of 8d. per gallon, to home-produced motor spirit, with the avowed object of encouraging home refining.

It was apparently anticipated that the more important groups distributing petroleum products in Southern Ireland, controlling The Texas Company (Ireland), Irish American Oil Company, and Irish Shell Limited, would establish a combined refinery within the country, and this course was actually suggested to the companies.

By establishing a domestic refining industry, it was hoped to provide in course of time for the whole of the 1,000,000 bbl. of motor spirit, plus other products, consumed annually in the Free State. The usual arguments of economic self-sufficiency, assistance to national defence, and increased employment were put forward in support of the tariff preferential.

All angles of refining in Ireland were carefully studied by the major groups concerned. Their conclusion was that to undertake refining in the Irish Free State would be uneconomic and impracticable, although one small distillation plant, operated by Cork Harbour Oil Wharves in association with the Lobitos group, has been working for some years. Through-put of this plant, however, is no more than 600 bbl. per day.

Failing to convert the larger companies to the home refining theory, the Free State authorities nevertheless were determined that the country should have its own refining business, and granted a manufacturing monopoly to Irish National Refineries last year. The company formed has a capital of £1,000,000, and an allied concern has been registered under the title of Liffey Transport and Trading Company to look after distribution, including export business. This undertaking also has a capital of £1,000,000. A small concern, Liffey Trust Limited, has since been formed with a capital of £20,000 to underwrite and deal in stocks and shares.

With the formation of Irish National Refineries, Thomas C. J. Burgess, chairman and joint managing director of London and Thames Haven Oil Wharves, Limited, and William Rhodes Davis, of Parent Petroleum Interests Limited, came into the picture.

There is no need to look far for the interest taken by W. R. Davis in a project of the Irish National Refineries type. For some years he has been something of a stormy petrel in the oil industry. President of Foreign Oil Corporation, Boston and New York, with interests in Germany and Denmark, Mr. Davis had already become well-known in Britain as sponsor of Crusader Petroleum Industries, Ltd., a company concerned at one time with the supply of petroleum products to independent distributors in the British market, and also concerned with a reputed endeavor to buy the Italian shareholding in Mosul Oilfields, Limited. Having also been mainly responsible for the formation in Britain of Parent Petroleum Interests, with a nominal capital which then consisted of £2,500,000 and which has now increased to £4,500,000, Mr. Davis was obviously looking for an outlet for his energies in the British Isles.

T. C. J. Burgess

Logical reasons for the participation of Mr. Burgess are more difficult to suggest. London and Thames Haven Oil Wharves had built up under his management a commercial business so sound that it seemed to the outside observer to require no embellishment by the acquisition of new interests. Thames Haven's topping and storage plant held virtually a monopolistic position in the Port of London. It is considered in the trade to give good service and to charge good prices for its facilities, and has a long period of commercial success to its credit.

In the course of its normal business of providing public storage, the London and Thames Haven installation naturally has been used for much of the oil marketed in and around London by the smaller independent operators. Many of these are sound and well established concerns but the trade occasionally attracts adventurers interested only in quick profits. Business of this kind, when in the hands of the fly-by-night type of small operator results in disturbed market conditions. It may be that because of the opportunities it afforded such

traders the national companies may have looked upon Thames Haven as a mixed blessing at times. Shell-Mex and B. P., Ltd., and Anglo-American, however, have used Thames Haven's facilities extensively. Reading between the lines of Mr. Burgess's addresses to his shareholders, it seems that, at least as far as the Shell Company is concerned, relations with Thames Haven have been gradually losing their former cordiality. While this may have been due to sentimental reasons to some extent, it is attributable in part to changes in the Shell group's own storage capacity.

In 1927 the production of the Royal Dutch-Shell group was running greatly ahead of storage, which led to a storage and topping contract on highly advantageous terms for London and Thames Haven. This contract lasted until about 1932, when the group's storage was more adequate and the contract with Thames Haven lapsed. It has been suggested that the end of this remunerative business was the turning point which set Mr. Burgess looking for new sources of income for London and Thames Haven. As a strong advocate of the internal refining theory, he would, when searching for a new field of influence, naturally be attracted by the refining scheme proposed by the Free State authorities.

Whatever the actual circumstances under which Mr. Burgess and Mr. Davis originally became associated, their first business connection apparently arose as a result of the Irish refinery plans. Parent Petroleum Interests was registered in April 1936, while negotiations in Ireland were in progress, and Mr. Burgess was announced as a director of Parent Petroleum in the following month. Shortly afterwards, Mr. Davis's name seemed to drop out of the limelight in Ireland.

Another personality now closely associated with the Irish project is Lord Inverforth, a director of British Union Oil Company and of a number of important British concerns outside the oil industry. Lord Inverforth, following the severance of his connection with the Jersey Standard interests, became associated with the Irish scheme at about the time when the Burgess-Davis alliance was formed, and he has now joined the board of London and Thames Haven Oil Wharves.

Whatever its origin, the association of the three in Ireland brought them into direct conflict with the interests of the groups controlling Irish American, Irish Shell, and the Irish subsidiary of Texas. Like all major oil groups, these companies are basically opposed to petroleum monopolies of all kinds on the grounds that they are uneconomic, and operate unfairly, not only to oil companies but to the consumer. Their attitude toward the proposal to establish a refining monopoly in the Free State found expression in a statement published in March last over the signatures of F. J. Wolfe for Anglo-American and F. L. Halford for Shell-Mex and B. P.

In this statement the companies drew attention to the contribution which their business had made to the welfare and progress of Ireland, but added that their experts had reported that economically the refinery

Lord Inverforth

project could not be recommended. The main reason given for this view was that the specific quantities of oil products consumed in the Irish market could not be produced by refining crude from a single source, but required blending on a large scale. No local refinery, it was held, could produce the range and quality of finished products required for Ireland except at extravagant costs, owing largely to the small size of the market compared with the plants from which the present supplies are drawn. The statement emphasized the fact that a refinery would not create continuous employment for many workers, and concluded with a strong hint of withdrawal from the Southern Irish market if the refinery project is carried through.

Although The Texas Company did not join in the declaration, it is undoubtedly in full concurrence with it as a statement of fact. Texas has made no announcement as to the possibility of its retiring altogether from distribution in Southern Ireland, but it may be assumed that the company will not act counter to the policy of its friends.

That in the circumstances the distributing companies contemplate withdrawl from the Irish Free State, after putting a considerable amount of capital into the country, is a measure of their opposition to the Irish refinery plan, carrying, as it does, the suggestion that they should use their established distributing organisations for selling the home-refined product to the Irish public. Their interests in Southern Ireland, although worth preserving under reasonable conditions, would not be of sufficient importance to them to justify the break with tradition involved in selling under their own brand names products which they had not refined themselves and the specifications for which they could not control.

Such a concession to expediency, it is claimed, would in any case destroy the goodwill they have built up in Southern Ireland, where the public would quickly come to realise that all brands of spirit offered to it were identical.

An even more serious consideration for the companies would be the risk of damage to their reputations in other distributing markets. The groups controlling the big Irish distributors have spent many years and enormous sums of money impressing on the world that their brands stand for individual and uniform excellence. Abandonment of individuality, even in the relative small Irish Free State market, might give competitors elsewhere a loophole for saying that brand names of the groups engaged in Ireland went for very little as a guarantee of high quality.

Following closely on the statement by the distributing companies, a reply was issued by the Irish National Refineries indicating confidence in the ability of that concern to meet the requirements of the market. This statement ended with the phrase "If we are, in addition, called upon by the Government to perform the duties of the distributing companies, we shall be able to supply the public without inconvenience and, not having to subsidise losses elsewhere, have every hope of even giving the public a price advantage".

Coming after the carefully worded statement of the distributing companies, the Irish National Refineries' bellicose and slightly spiteful reference to "not having to subsidise losses elsewhere" was considered highly injudicious in British oil circles. In the first place, the implied criticism of opponents was interpreted as a sign of weakness; in the second, it is open to direct challenge on a question of fact.

Companies distributing in the Southern Irish market maintain that, far from subsidising losses in other markets from profits made in the Free State, they have themselves subsidised the Irish consumer to the extent that for some years the building up of goodwill, and the development of a market in a sparsely populated agricultural country, has involved them in losses in Ireland. Only recently has a general profit been shown, and the margin over costs is stated to be still extremely narrow.

Since the distributors in Southern Ireland are opposed to handling products of the Irish National Refineries, there is practically no prospect of their agreeing to supply the refinery with crude. Integrated oil groups at the present time are not interested in selling crude as such. Their function is the complete and efficient co-ordination of production, refining, transport and distribution. Irish National Refineries, therefore, will hardly be able to look to any of the world's major groups for crude supplies. The acquisition of any continuous supply of crude in Britain is, in fact, a difficult matter nowadays. Odd cargoes may be easy to come by at times, but contracts for successive deliveries over any reasonable period are almost out of the question.

Nevertheless, the question of crude is a vital one for the new Irish undertaking. Assurance that crude supplies will be forthcoming has been given to the Free State authorities, and Mr. Burgess told London

and Thames Haven shareholders at the recent annual meeting that part of the £500,000 increase in the company's investment holdings during the past year was due to the acquisition of interests which would provide the company's allies (Irish National Refineries), with a sufficiency of crude production to render them safe from attack from any quarter.

Where those new interests lie was not specified by Mr. Burgess. Three possible quarters are envisaged by outside observers as possible sources of crude for the Irish refinery. Crusader has a property in Texas, Davis holds interests in a Mexican area, and Lord Inverforth has a new concession in Trinidad and a small area in Barbados. If current rumor in London is to be credited, however, neither the Texas nor the Mexican properties are as yet developed to the point of providing a crude supply while the Trinidad area has not even been adequately prospected. The Barbados output of British Union Oil is, of course, very small.

Conceivably, Foreign Oil Corporation can lay its hands on adequate crude supplies for Irish refining, but if so, say its critics, why the necessity for a big investment by London and Thames Haven for this purpose, and why the secrecy as to the source of supplies?

If the question of crude supplies is a critical one, an equally pressing problem for the Irish National Refineries backers is that of finance. Although this company and Liffey Transport and Trading each has a nominal capital of the imposing figure of £1,000,000, the issued capital in each case, according to latest official details, is only £10,000, consisting of seven shares issued to nominal subscribers, and 9,993 issued to Liffey Trust. Since the cost of registration and other initial outgoings is put at about £6,000 for each company, there apparently is no effective working capital in the group as yet.

Underwriting of a public capital issue in Ireland for the refinery appears to be practically impossible, and application to the Industrial Credit Company has been equally unsuccessful. This Corporation is a semi-official concern, which advises the Free State government on the desirability of guaranteeing industrial projects. It has a reputation for considerable acumen and sound judgment, and is stated to have turned down, on more than one occasion, the suggestion that the refineries project is a suitable proposition for a Free State government guarantee. Without such a guarantee, it seems unlikely that the refinery will be able to raise money from the Irish public.

Another possibility is that funds for Irish refining will be put up by Thames Haven Oil Wharves. Mr. Burgess stated at the recent meeting that proposals will in due time be put before shareholders in conjunction with an issue of shares in Irish National Refineries. Except for the friendly attitude of the few present at the meeting, the reaction of Thames Haven shareholders to this proposal is not evident. In considering possibilities of their welcoming the new project, however, account must be taken of the set-back, through unfavorable conditions in France, sustained last year by Compagnie Industrielle Maritime, Thames Haven's Havre subsidiary.

For the present, Parent Petroleum Interests may be supplying the financing required for the Irish refining scheme. The issued capital of Parent Petroleum, out of the £4,500,000 authorised, is £1,250,000. Of this, £500,000 is held by W. R. Davis and practically all the remainder in the names of bank nominee companies. For whom they may be acting of course does not appear in the record.

It is reported that one outstanding part played by Lord Inverforth in the general scheme is the financing of the seven large tankships now building in Germany for Crusader, which fleet has probably appreciated 10 to 20 percent in value since the contracts were placed. Presumably, Lord Inverforth's company, Andrew Weir and Company, will manage the operations of these ships. Consequently, whatever the outcome of the refinery proposition, Lord Inverforth's position will be entirely secure.

While questions of finance and of crude supplies may remain unsettled plans for the actual construction of the Free State refinery are being pushed ahead and it is reported that orders for some of the equipment required already have been placed. That it is possible to build and operate such a refinery is not open to question. That it may be conducted with profit to its owners if it holds a monopoly of the business is equally obvious. What impartial observers are unable to see is how it can bring any real benefit to the Irish Free State or to the consumers of petroleum products in that country.

Meanwhile, direct association with the Irish project has completely changed the position of London and Thames Haven Oil Wharves. This is evident from the fact that the company's £1 shares, which stood at over £4 a year ago, had fallen to around £2 by April this year. The decline, which has taken place without any reduction being made in the dividend, apparently represents apprehension by investors that the interests of the company have changed from a sound and well-established storage business to more speculative enterprise, first at Havre, and now in Ireland.

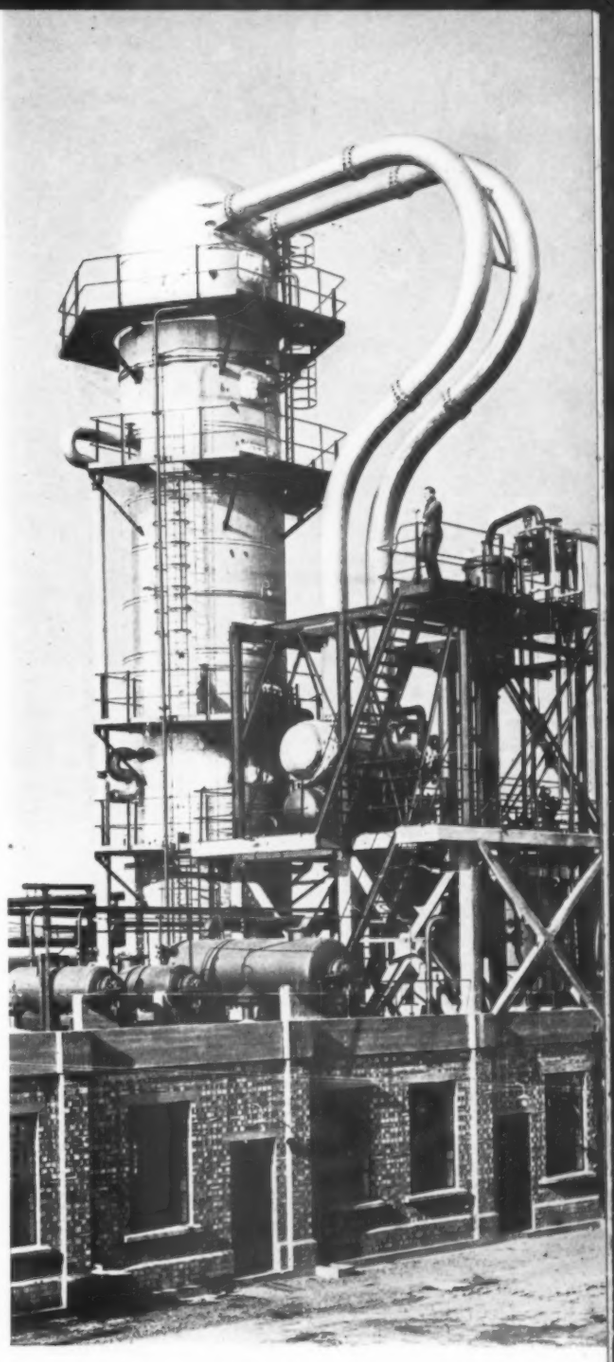
Reference at meetings during the past three or four years has been made by Mr. Burgess to the changing attitude of some of the major groups which were the company's particular clients. He went into further detail at this year's meeting in the following statement:

"We had up for renewal one of our important contracts. We did, in fact, renew it, but on terms which we made quite plain were not satisfactory to us, and there was imposed in this contract the variation giving our clients power to terminate at 12 months' notice instead of two years. As a matter of fact, the contract came into force on January 1 of this year, and simultaneously notice was given to terminate in 12 months' time from that date."

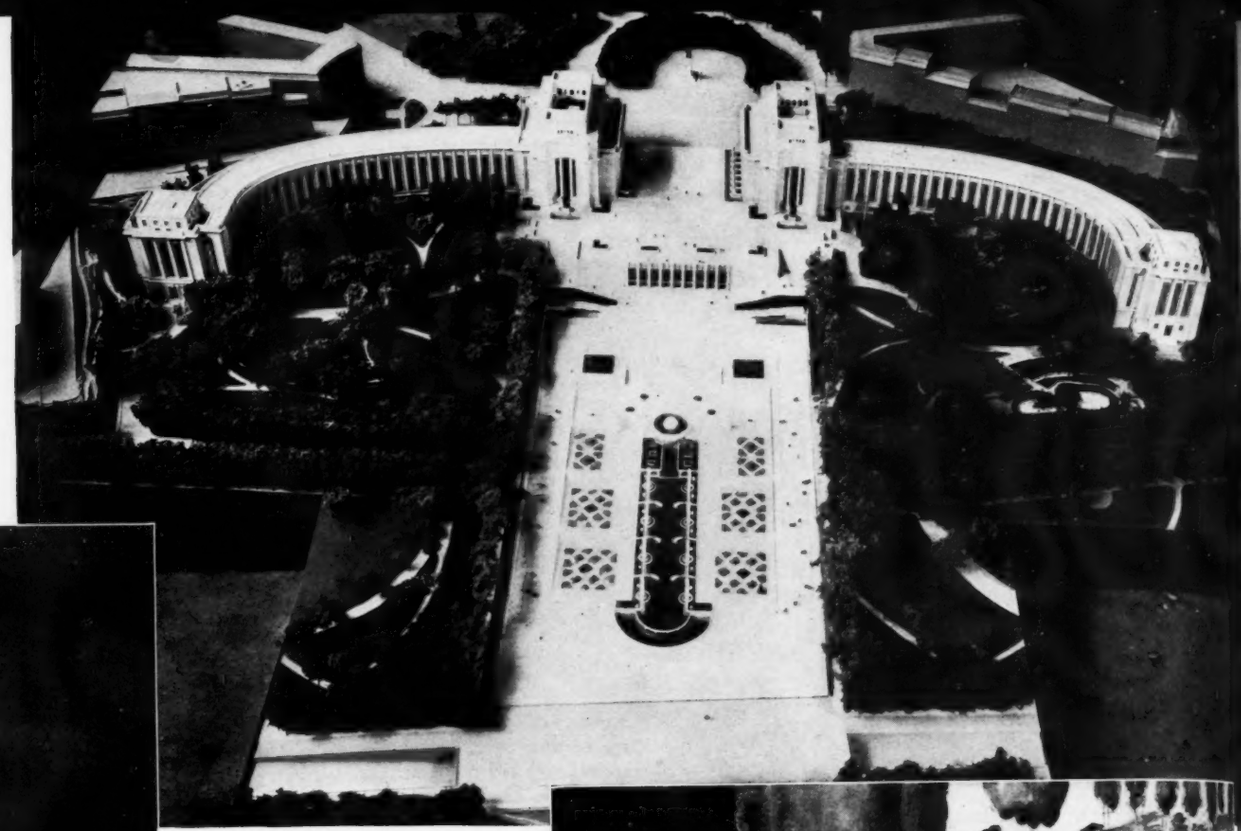
The contract referred to was with the Shell group, and notice of its termination may be considered a reflection of the change in relations between the major companies and Thames Haven, resulting from the participation of the latter in the Irish refinery scheme. It is, of course, not to be expected that the major groups distributing in Britain will give support to a company engaged in a project which bids fair to oust them from the Free State market.

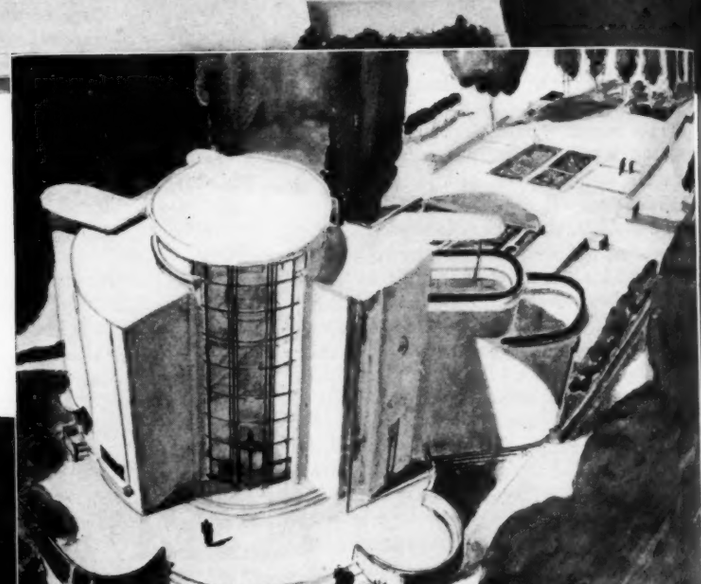
Termination of the specific contract mentioned by the Thames Haven chairman may be taken as a sign of future action by the national companies, although, since the contracts for storage expire at relatively long intervals, any adverse effect on Thames Haven's business would, in the worst circumstances, be gradual. Although gradual, the effect of the lapsing of big contracts on

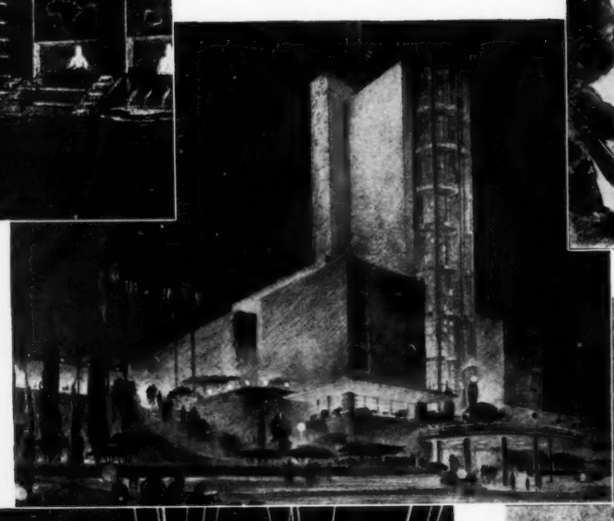
(Continued on page 55)

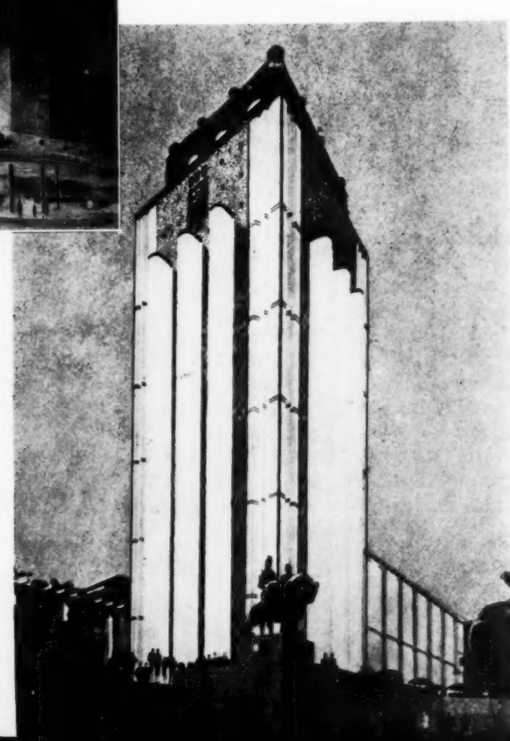


Recently constructed combination atmospheric-vacuum distillation unit at Thames Haven, designed by Foster Wheeler, Ltd.









The Paris Exposition as visualized by the distinguished artists who designed the buildings. Above is a view of the New Trocadero; the structure in the center of the page is the American building while the pyrotechnic display will be known as the Fête of Lights

AMERICAN DELEGATIONS FORMED

To Attend Second World Congress

PLANS for the Second World Petroleum Congress to be held in Paris June 14 to 19 this year have progressed rapidly and have attracted considerable attention in the United States. In view of the fact that the Congress will be held in Paris during the International Exposition—some striking pictures of which are reproduced on this and the facing page—and very shortly after the festivities surrounding the Coronation in England, the attendance from this side of the Atlantic is expected to be quite large.

Mr. D. E. Buchanan, president of Hanlon-Buchanan, Inc. of Tulsa, Oklahoma has accepted the invitation of Secretary of State Cordell Hull to act as chairman of the official United States delegation. Mr. Buchanan has also been appointed chairman of the American Petroleum Institute delegation to the Congress. It is interesting to note that Mr. Buchanan personally arranged for the sale of the first cargo of natural gasoline ever to be exported from the United States to the independent market abroad; it is a little startling to recall that this sale was made only 11 years ago, in 1926. The annual value of natural gasoline exported from the United States is now $4,203,682 while in 1926 there was considerable skepticism in Europe as to the possibility of shipping cargoes of natural gasoline from the United States.

Mr. Buchanan will present before the Congress a most interesting paper on a subject in which he is an expert—"Natural Gasoline in the World Motor Fuel Market." Plans for definite participation of Mr. Buchanan's delegations are now practically complete.

Other members of the official U. S. Delegation and of the American Petroleum Institute delegation are: Herbert Baxley, Socony-Vacuum Oil Company, William M. Brewster, Raffineries de Petrole de la Gironde, W. D. Crampton, Standard Oil Company of New Jersey, H. A. Hassan, Sinclair Refining Company, Charles E. Lanning, American Petroleum Institute, Wallace Pratt, Humble Oil and Refining Company, C. B. Veal, Society of Automotive Engineers. In addition, the United States delegation consists of Col. James Gordon Streese, U. S. Army, retired, and Charles W. Wright, United States vice consul at Vienna and mineral specialist of the U. S. Bureau of Mines. Other members of the A.P.I. delegation are: Dr. Gustav Egloff, Universal Oil Products, P. G. Bellemare, Compagnie Industrielle des Petroles, Phillippe Berard, Vacuum Oil Company, S.A.F., and Dr. C. K. Francis, Oil and Gas Journal.

Dr. Egloff is in charge of the refining section of the Congress as has been announced earlier in WORLD PETROLEUM.

D. E. Buchanan, president, Hanlon-Buchanan and U. S. representative to World Petroleum Congress.

Other members of the Committee headed by Dr. Egloff, known as the Comité d'Organisation, are: Sydney Born, University of Tulsa, B. T. Brooks, Consulting Chemist, W. A. Gruse, Mellon Institute, R. A. Halloran, Standard Oil Company of California, K. G. MacKenzie, The Texas Company, Walter Miller, Continental Oil Company, W. L. Nelson, University of Tulsa, J. B. Rather, Socony-Vacuum Oil Company, R. P. Russel, Standard Oil Development Company, T. N. St. Hill, Petroleum Rectifying Company, F. W. Sullivan, Standard Oil Company of India, Cary Wagner, Pure Oil Company, T. G. Delbridge, Atlantic Refining Company, C. B. Buerger, Gulf Oil Corporation, H. W. Camp, Empire Refineries, Inc., Emby Kaye, Skelly Oil Company, and A. E. Lacomble, Shell Petroleum Corporation.

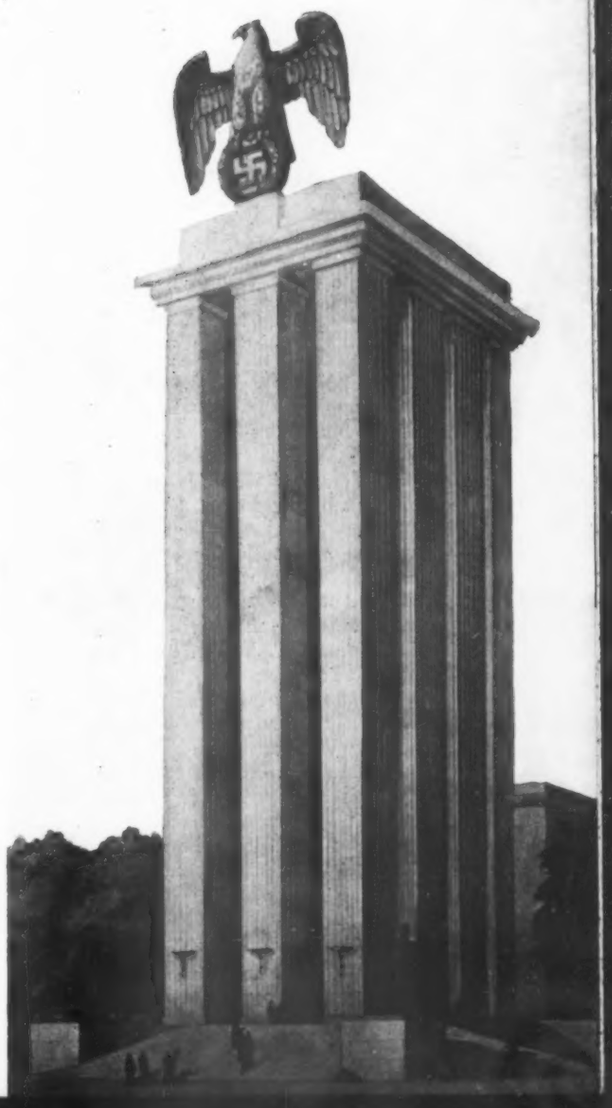
Some of the papers that have been collected in the United States and have been forwarded to the Congress headquarters at 85 Bd du Montparnasse, Paris are: "Progress in Petroleum Production in The United States for the Years 1935–1936," a paper on "Improvements in Rotary Drilling Equipment Since 1933" by J. E. Brantly, well known Pacific Coast and Texas operator, whose articles on this subject have appeared from time to time in WORLD PETROLEUM and PETROLEUM WORLD.

Another American paper recently submitted deals with "Modern Pumping Practice" by J. J. Donnelly and a paper on "A Bibliography on Nomenclature and Measurements." It is hoped that Dr. E. E. Rosaire will submit a paper on progress of geophysics since 1933 which should prove a most interesting contribution.

Fortunately, the Secretary General of the Congress recently announced that the last date on which papers could be received for the Congress had been moved from April 15th to May 10th.

It is understood that the Director of the U. S. Bureau of Mines in Washington has been compiling some statistics for the Congress but the titles and authors of the papers that are being forwarded through his office are not available. Mr. W. P. Haynes, Standard Oil Company of New Jersey, who recently shifted his headquarters from London to New York has been collecting papers prepared in the United States and forwarding them to Congress headquarters at Paris.

Proposed German pavilion for the Paris Exposition.



GREAT BRITAIN Deficient in Tanker Tonnage

From a Defence Point of View

THE UNITED KINGDOM, a manufacturing country with a large population on a small area and at the centre of an overseas Empire, is more than any other country dependent on merchant shipping for its very existence. Shipping is required in order to bring to the United Kingdom food and raw materials. These are paid for by the exports of coal, manufactured articles and to a large extent by invisible exports, such as shipping services. Merchant shipping is vital also for the maintenance of communications with the Empire. Rapid displacement of coal by oil in the last 25 years has made important changes in the kind of vessel necessary to fulfil these objects.

A few simple examples will illustrate this. In 1913, the last trading year before the war, United Kingdom exports amounted to 94,000,000 tons by weight, and coal, coke and manufactured fuel accounted for 77,000,000 tons of the total, the remaining 17,000,000 tons consisting mainly of manufactured goods and of 2,000,000 tons of re-exports of previously imported merchandise such as rubber, wool and tea. The weight of imports, consisting mainly of food and raw materials, was 56,000,000 tons. Both imports and exports were largely carried by tramp ships for which coal provided outward cargoes and which carried grain, ore, timber, etc., homeward. There was an outward balance of 38,000,000 tons, and British tramp ships carried homeward cargoes not only to the U.K. but to other European countries and carried also between one foreign country and another.

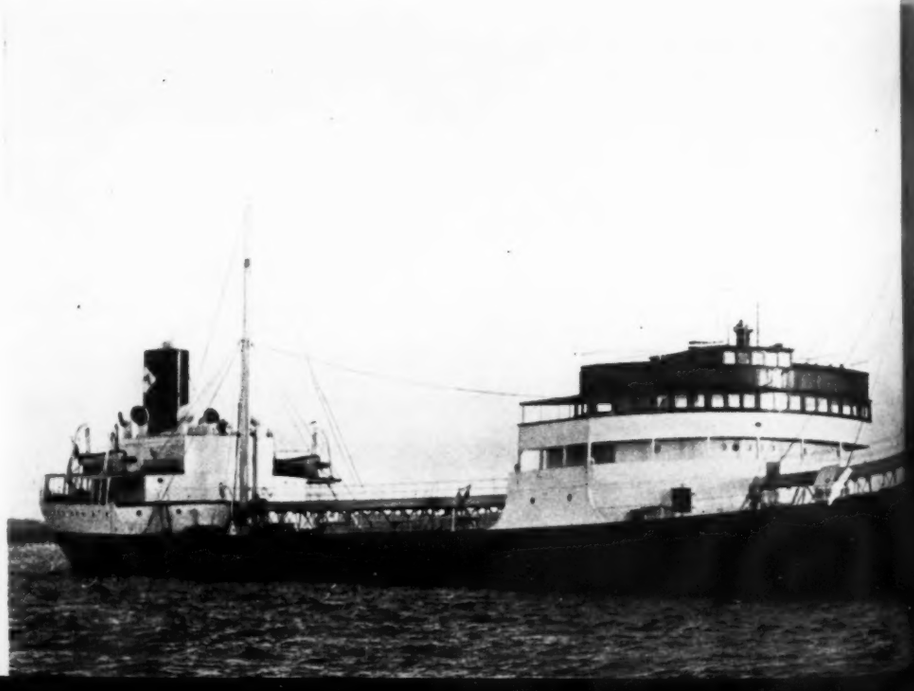
The world's total seagoing steam and motor tonnage, excluding that trading on the Great Lakes of North America, was just over 43,000,000 gross tons, of which the United Kingdom owned nearly 19,000,000 gross tons, or 44 percent. Taking tonnage owned in the Dominions into account, British Empire tonnage amounted to 20,500,000 gross tons, or over 47½ percent. At that time oil played a comparatively small part in world economy and the world total of seagoing tonnage included only 434 tankers of a little over 1,500,000 gross tons. In this new trade British shipping was well represented; 200 tankers representing more than half the tonnage, were owned in the British Empire. The only other important tanker owning countries were United States with 92; Germany with 43; Holland with 38 and Norway with 11 tankers. The British Navy already had big oil requirements, but the oil-burning steamer was not fashionable and the motor ship had barely come into existence.

Today the position is entirely different. The demand for coal has fallen and oil has taken its place. The dependence of the United Kingdom on oil has grown enormously. In 1913 total imports of oils were 488,000,000 gallons, of which only 101,000,000 were motor spirit. By 1936 the imports of oil had increased exactly 600 percent to 2,928,000,000 gallons. At the same time the balance of cargoes by weight had also completely changed. For a larger population imports had naturally grown, and amounted to 63,000,000 tons in 1935 compared with 56,000,000 tons in 1913, but exports fell from 94,000,000 tons in 1913 to 54,000,000 tons in 1935. Chief element in the difference was the fall in exports of coal and coke from 77,000,000 tons to 42,000,000 tons in 1935. Increasing competition, trade barriers, efforts at self-sufficiency made by various foreign countries, reduced the exports of other goods including re-exports, from 17,000,000 tons in 1913 to 12,000,000 tons in 1935. It would naturally be expected that corresponding changes would take place in the numbers and types of ships owned in the United Kingdom, but an examination of the figures shows that this has not been anything like the case. World seagoing steam and motor tonnage increased from 43,000,000 tons in 1914 to 61,000,000 tons in 1936, but the tonnage owned in the British Empire actually fell from 20,500,000 gross tons in 1914 to 20,200,000 gross tons in 1936. World tanker tonnage increased from 1,580,000 gross tons in 1914 to 10,210,000 gross tons in 1936, and there are indications that the world's supply of tanker tonnage is still not sufficient to meet the increase in movement of oil. New construction is rapidly proceeding, particularly in Japan. How does the United Kingdom stand? Of her smaller total of merchant shipping, tanker tonnage accounts for 2,640,000 gross tons, or less than 26 percent of the tanker tonnage owned in the world as contrasted with over 50 percent in 1914. In fact both the United Kingdom and British Empire as a whole have a rather smaller proportion of seagoing tanker tonnage than they have of steam and motor shipping. For the United Kingdom the increase in tanker tonnage in the period has been 350 percent, whereas we have seen above that the increase in oil imports has been 600 percent.

While exports of coal and coke have fallen by 35,000,000 tons, imports of petroleum have increased by nearly 10,000,000. The position is serious, not only from the economic but also from the defence point of view. Of 17,200,000 gross tons of merchant shipping owned in the United Kingdom, 3,200,000 gross tons are motor vessels and 5,200,000 gross tons are steam vessels burning oil fuel, making a total of 8,400,000 gross tons, or over 48 percent dependent on oil fuel. Corresponding figures for 1913 were of course negligible.

The British Navy is almost entirely dependent on oil fuel. Seeing that Britain's supply of tankers is insufficient for her own needs one is naturally led to an examination of the tanker tonnage under other flags. United States with 2,590,000 gross tons owns nearly as much tanker tonnage as the United Kingdom but much of it is used in its own coastal trade, and the rest in carrying United States and Mexican oil to foreign countries. Norway owns another 1,680,000 gross tons. Her own requirements of oil are naturally small, and this tonnage is available for world distribution of petroleum in general.

In a state of emergency such as the last war Great Britain would be driven, unless her supply of tankers rapidly increased, to dependence on neutral tanker tonnage of which presumably that owned in Norway would be the most readily available. It may be recalled that in the Great War when the allies depended on British tonnage, and the allies and United Kingdom supplemented their requirements by such neutral tonnage as was available, over 7,000,000 gross tons of Great Britain's shipping were lost by enemy action. The position of the allies was helped in the early stages by the friendly attitude of the United States who, as a neutral, was



naturally keen on maintaining her trade and later when the United States entered the war by its energetic shipbuilding program.

Today the position is different. The United States is determined not to be again involved in a European war if it can possibly be helped and to restrict her trade as a neutral so as to prevent a war boom and the piling up of foreign loans.

One further aspect needs emphasizing. We have seen that British shipping, tramp and cargo liner, has fallen in numbers and tonnage, and that while tanker tonnage has increased, it has not done so to an equivalent extent even when measured in gross tonnage, but this is an incomplete picture. The average carrying capacity of 100 gross tons of tramp shipping is 170 deadweight tons. In other words when fully employed, as is the

(Continued on page 55)

ALBANIAN FIELDS to Supply Italy

By Rudolph Seiden, C. E.

ALBANIA, like many other oil-producing countries such as Russia, Iraq, Iran, and British India, was originally the seat of ancient fire-worshipping cults tending their "Eternal Flame" and conducting religious ceremonies for devout pilgrims who journeyed from afar to make obeisance to the great miracle. Strabo, Cassius, and other early writers and historians made reference to the "Everlasting Fires" of the region. Apart from the minor, but age-old, asphalt mining industry at Selenica, in the Vjosa valley, which product was converted into mastic chiefly for building purposes, the petroliferous resources of the country never received any particular attention.

Prior to the outbreak of the World War there was apparently only one investigation conducted to determine Albania's natural resources, and that was of but a minor character directed by Coquand, the French geologist. It was, perhaps, a factor leading up to further investigation by Austro-Hungarian authorities and private interests during hostilities and after the armistice, when the Albanian government summoned geologists from abroad and commissioned them to survey the country's resources with especial attention to the bituminous deposits and possibilities for discovery of oil and gas. Among those engaged in this undertaking were Dr. Ernst Nowak of Vienna, who collaborated with Albanian geologists, Dr. S. Zuber of Lwow, Dr. N. Maddalena (representing the Italian government) whose activity was chiefly along the Adriatic coastal districts, and Captain Plate of Milan, who investigated the south Albanian fields. It was hoped that these surveys would indicate more than a bare possibility of the existence of commercial oil supplies. This proved to be the case. Independent conclusions of these consultants were that drilling for oil in quantities capable of economic exploitation was entirely feasible, and before long a number of oil companies sought concessions from the Albanian government.

Up to that time the only properties worked were the asphalt pits of Societa Italiana delle Miniere di Selenizza (SIMSA), at Selenica, who are understood also to have drilled the first successful oil wells some six miles from Valona in the Sushica valley. Despite the early interest of the Italians in exploring and exploiting the country, the first oil concession was granted to a British group. This was an area of 85,000 acres granted to Anglo-Iranian (then Anglo-Persian) Oil Company Ltd. Altogether this company was offered nearly 500,000 acres for exploration purposes and about 125,000 acres for actual exploitation. Five weeks later, in March, 1925, two concessions in Tirana were granted to Italian interests; three zones aggregating 116,000 acres were received for exploration by Ferrovie dello Stato d'Italia (Italian government), which was later reduced to 31,193 acres for exploitation, and another 5,310-acre oil concession was received by SIMSA—previously only engaged in producing and exporting asphalt. Other concessions granted at short intervals included two zones of 127,000 acres to the Standard Oil Company of New York, 74,000 acres to Franco-Albanaise Syndicate, and a concession of 21,120 acres was granted to Henry H. Rushton, an Englishman whose name is associated with the development of the small oilfield on the island of Zante, in Greece. The French syndicate, which was founded from the Credit Generale des Petroles, subsequently changed its name to Societe Industrielle et Commerciale des Petroles.

Each of the concession-holders was obliged to pay the Albanian government an annual rent of Fr. 1.50 per 2.75 acres as well as a 13.5 percent tax on gross production, should any be obtained. Although a decade has passed since the granting of these 60-year concessions the Italians are practically the only ones to have continued their operations. Most, although not all, of the companies once interested did go so far as to drill a number of wells, more especially the English and French interests, but they came to the conclusion that for the present at least the quantity of crude obtainable was not sufficient to justify large capital investments in Albania, and their concessions were forfeited.

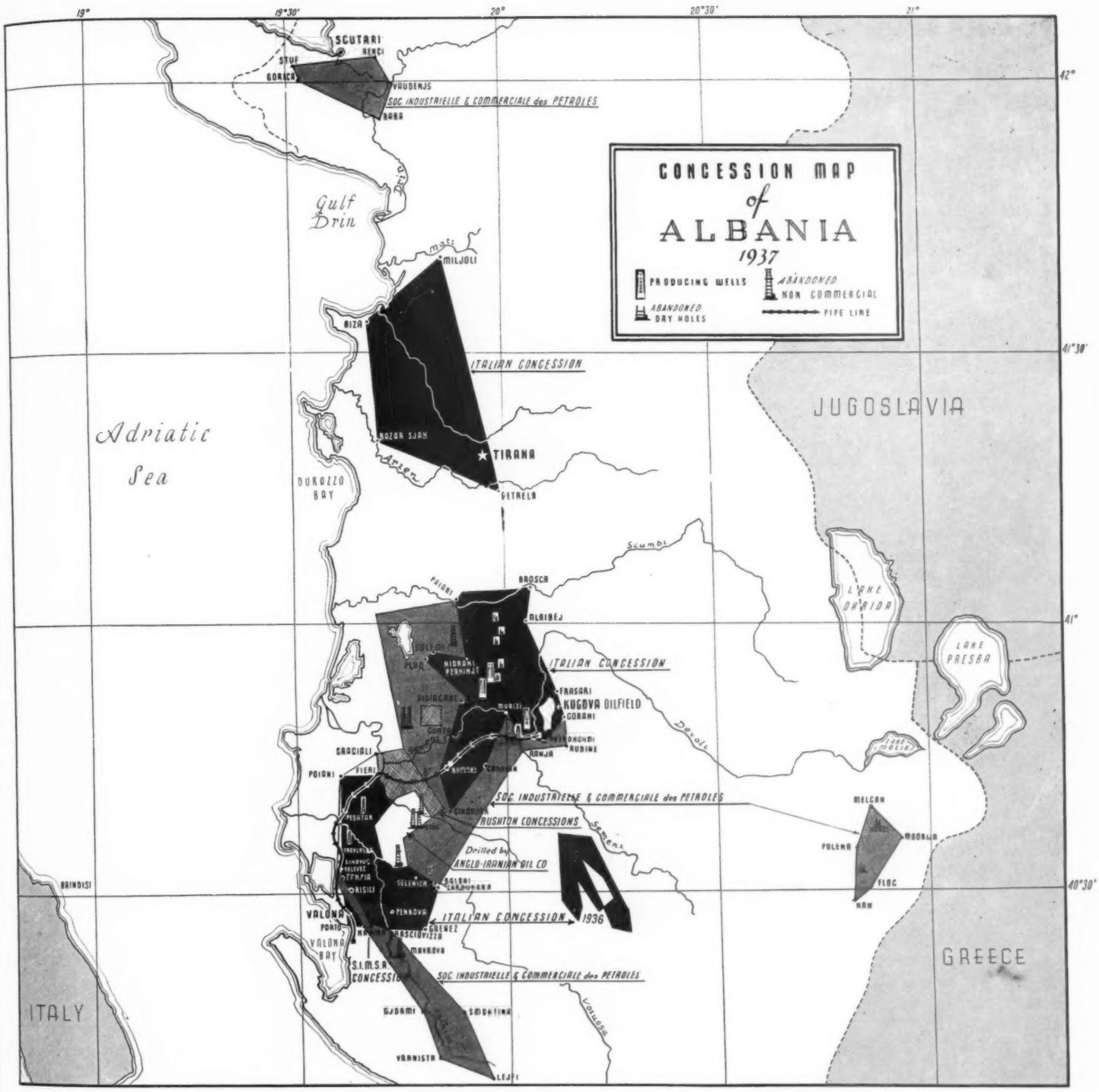
The French company recently renewed its concession, depositing a guarantee of Fr. 35,000 in gold, over four perimeters covering a total area of 470,650 acres upon which it can conduct test drilling and out of which 64,130 acres will have to be selected for exploitation. Two wells have been drilled to depths of 984 ft. and 1,304 ft. respectively, at Korce, where traces of oil were found and a great deal of gas. Another well was drilled to 3,609 ft. at Mavrova without positive results while a fourth was sunk at Devoli, near the Italian concession, which gave a maximum production of seven barrels per diem from horizons between 2,465 ft. and 2,608 ft. This flow has now fallen to three or four barrels daily.

The Italians, who have little indigenous oil and are favorably situated to Albania from a geographical standpoint, have probably been justified in remaining in these oilfields. Italy desires convenient oil production and here is a source which could be readily obtained to augment her own meagre output. In 1925 her nationals began drilling operations in Albania with 30,000,000 Lire of government money at their disposal. Two years later the Italian government parted with a further 50,000,000 Lire. What additional funds have been made available are not known. These activities have been carried on by Azienda Italiana Petroli d'Albania (AIPA), which is closely associated with AGIP—both government controlled and subsidized companies. In the first two years of its existence AIPA only made ten tests, but the company extended its drilling rights to 405,000 acres and then accelerated its operations. At the end of 1933 some 48 boreholes had been sunk, a total of 69,000 ft., and today more than 90,000 ft. have been drilled, the total number of wells being 60.

Figures for Albanian production were not published until about the end of 1926, for which year the output aggregated some 7,000 bbl. This increased to 10,500 bbl. the next year and up to the end of 1934 the production varied between 17,500 bbl. and 21,000 bbl. per annum. Oil was first produced from the Devoli-Kucova field in 1930 and now, as this section approaches complete development, it is spoken of as the center of the Albanian oil industry. The crude is obtained from the upper Miocene, Sarmatian which is between 1,500 and 2,500 ft. deep in this region. It is very black oil and has about 13% gasoline, 7% kerosene, 18% gas oil and 40% asphalt residue. The specific gravity is 0.93–0.96=20°–15° A.P.I. Other developments by Italian interests have been at Patos, Penkova, Selenica, Trevlaser, Selevec, Buzmazi and Sikovun, all of which are inland from Valona.

Immediately commercial-scale production was realized on a comparative basis a pipeline was laid by AIPA through the entire oil-bearing region along the new Italian-built road. This line has a total length of about 44 miles and serves the Devoli-Kucova field, which is somewhat north of Berat, passes through Fieri, Roskovec, Skrafotine, and terminates at Uji-i-Ftohet, in the bay of Valona. It is reported to have a daily capacity of about 5,000 bbl. of crude oil, and the wharves have been designed to handle some 2,000,000 bbl. per annum. Two storage tanks, each having a capacity of 25,112 bbl., were erected at the head station while six tanks of about 31,345 bbl. each are located at the harbor near the oil jetties.

The tanker MAYA, of Cisterna Italiana, carried the first crude oil cargo from Valona to Italy late in December, 1935, culminating that county's endeavors to increase its oil supplies. This shipment was 29,064 bbl. destined for AGIP's refineries.



It is the hope of Italy to ship at first about 700,000 bbl. of oil per annum, and to increase this to 2,000,000 bbl. in the near future. However, even should Italy realize her hopes in raising the Albanian output to such a degree it cannot materially affect the country's trade balance or even ensure to any appreciable extent fuel oil supplies during hostilities, even with the addition of her indigenous output of not more than 200,000 bbl. per annum.

The fact that Italy is willing to spend much capital, energy and time developing this small production despite the fact that purely commercial interests have given it up, make it evident that she is not looking so much for a profit-making enterprise as for the establishment of a permanent military fuel oil base, one which would be readily accessible at all times for her warships and airplanes. The limit of Albanian oil reserves has been liberally estimated at 70,000,000 bbl., and it has been suggested that while Europe could meet its oil demand for only a few weeks Italy's supply in Albania would last about five years. This would indeed be so if the potential production could be obtained within this period—unfortunately for Italy, however, the crude oil reserves in that country are far more likely to last ten times that long, but with an output in proportion to the life of flow and steadily diminishing with the years.

CORROSION RESISTANT Steel for Tankers

By Arthur B. Gowan, B.Sc., A.M. Inst., N.A.

STEEL in general use for ship construction at the present time differs very little from the low carbon mild steel introduced towards the end of the last century and it says something for this material that it has maintained its position for so long. Several factors have contributed to this state of affairs. Mild steel possessed such technical and economic advantages over iron that the latter material was comparatively quickly superseded and the notable advances in design and construction which followed led to a standardization of mild steel as the normal shipbuilding material. Standardization of practice renders successful introduction of a new material increasingly difficult as time goes on and the accumulated experience and data possessed by shipbuilders and by registration societies tends to produce an extremely conservative attitude towards claims of a new material to which, in the nature of things, this experience and data is not directly applicable.

Further, the properties of mild steel and its limitations are well known and steel of this description, of the usually accepted quality, is universally obtainable. Any new material proposed will, at any rate in the first instance, be of somewhat special and limited manufacture and may, the user feels, involve difficulties in obtaining supplies even if quality and properties leave nothing to be desired and assuming that the cost is such as to make the new steel an economic proposition.

In brief, mild steel owed its adoption to its marked superiority to iron and has maintained the position gained partly on merit and partly as a result of gradual standardization of shipbuilding methods based on use of a standard steel.

In consequence there is a tendency to overlook, or to take for granted as unavoidable, the shortcomings of low carbon mild steel considered from the point of view of the ideal shipbuilding material. Of these shortcomings perhaps the most obvious, and certainly not the least important to the man concerned with operation and maintenance of shipping, tanker tonnage in particular, is the liability of mild steel to rapid and frequently locally excessive corrosion and pitting. Steel was early found to be much inferior to iron in this respect; to such an extent indeed that some shipowners were in the habit of continuing to specify iron for those parts of their vessels most subject to attack long after steel had taken the place of this material for general use.

Low ultimate tensile stress of shipbuilding mild steel, ranging from 26 to 32 tons per square inch together with the somewhat indefinite yield point, which may be taken as being about half the ultimate stress, are further disadvantages limiting the scope of design particularly in the case of ships of very large size or special type. Use of excessively heavy low stressed members and introduction on a large scale of such devices as the heavy continuous doubling plate point to the need for a material capable of carrying higher working stresses.

Necessity for a shipbuilding material having properties superior to ordinary mild steel and manufactured to a more stringent specification has long been recognized by warship designers and the requirements of naval authorities have been met by the introduction of a variety of high tensile steels of higher carbon content than mild steel and containing varying quantities of manganese, silicon and other alloying elements.

These steels are of too expensive a character to be acceptable for mercantile shipbuilding and, in their development, attention has been directed rather towards the production of high tensile, bullet proof or armour plating than to obtaining the corrosion resisting and other properties more likely to appeal to the commercial user. Furthermore the various "Admiralty" steels are in general somewhat difficult to manufacture and require special treatment in fabrication.

More recently commercial steels of special quality have begun to be introduced and these are being increasingly used indicating that the deficiencies of ordinary shipbuilding steel are gradually being realized and a high standard of performance demanded. These special steels are characterized by possession of defined properties such as a specified high elastic limit, high yield point, high ultimate tensile strength or special capability to resist corrosion and all are alike in having the marked advantage over mild steel of a strictly specified range of properties and by being manufactured under carefully controlled conditions.

There are a number of different ways of obtaining the desired properties of increased tenacity and higher elastic limit by varying the amount of carbon, manganese and other constituents with or without subsequent special heat treatment after rolling while improved resistance to corrosion may be effected by addition of small quantities of copper. It would be beyond the scope of an article such as this to deal adequately with the subject in its wider aspects and it seems preferable to confine what follows to a consideration of a particular type of corrosion resisting high tensile alloy steel which appears to be specially suitable for shipbuilding

(Continued on page 45)

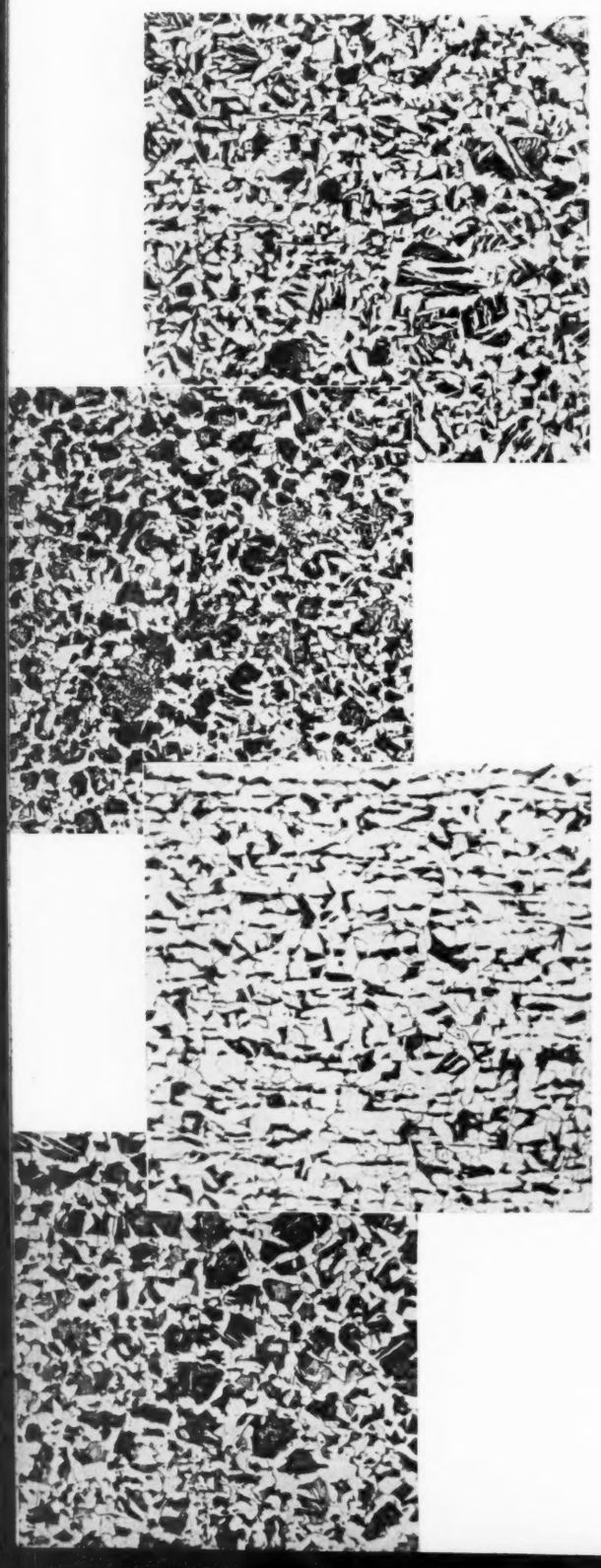


Photo-micrographic pictures of steel subjected to test magnified 150 times. Top to bottom: Mild steel, normalized; Chromium-copper steel normalized; Mild steel as rolled; and Chromium-copper steel as rolled.

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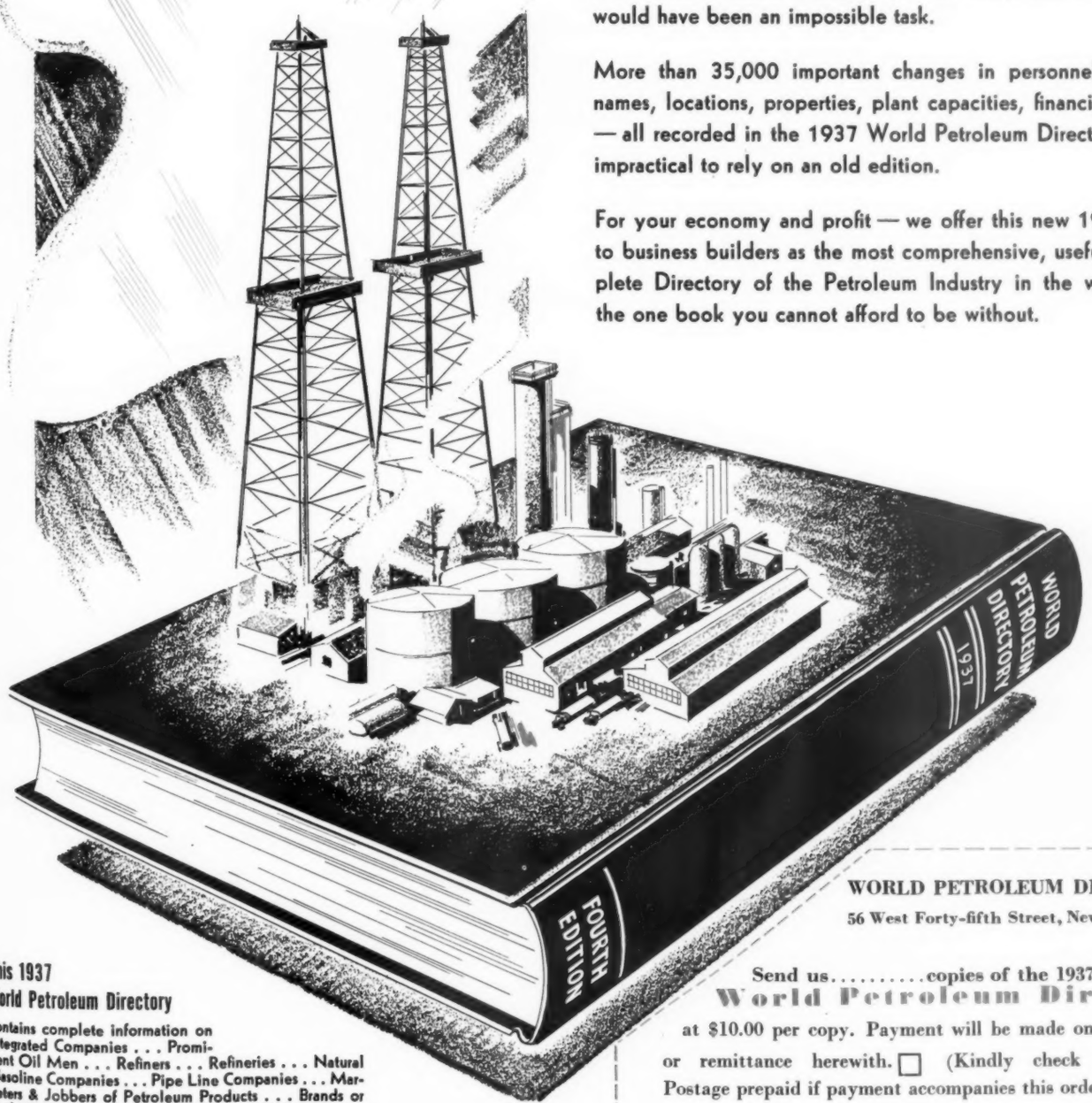

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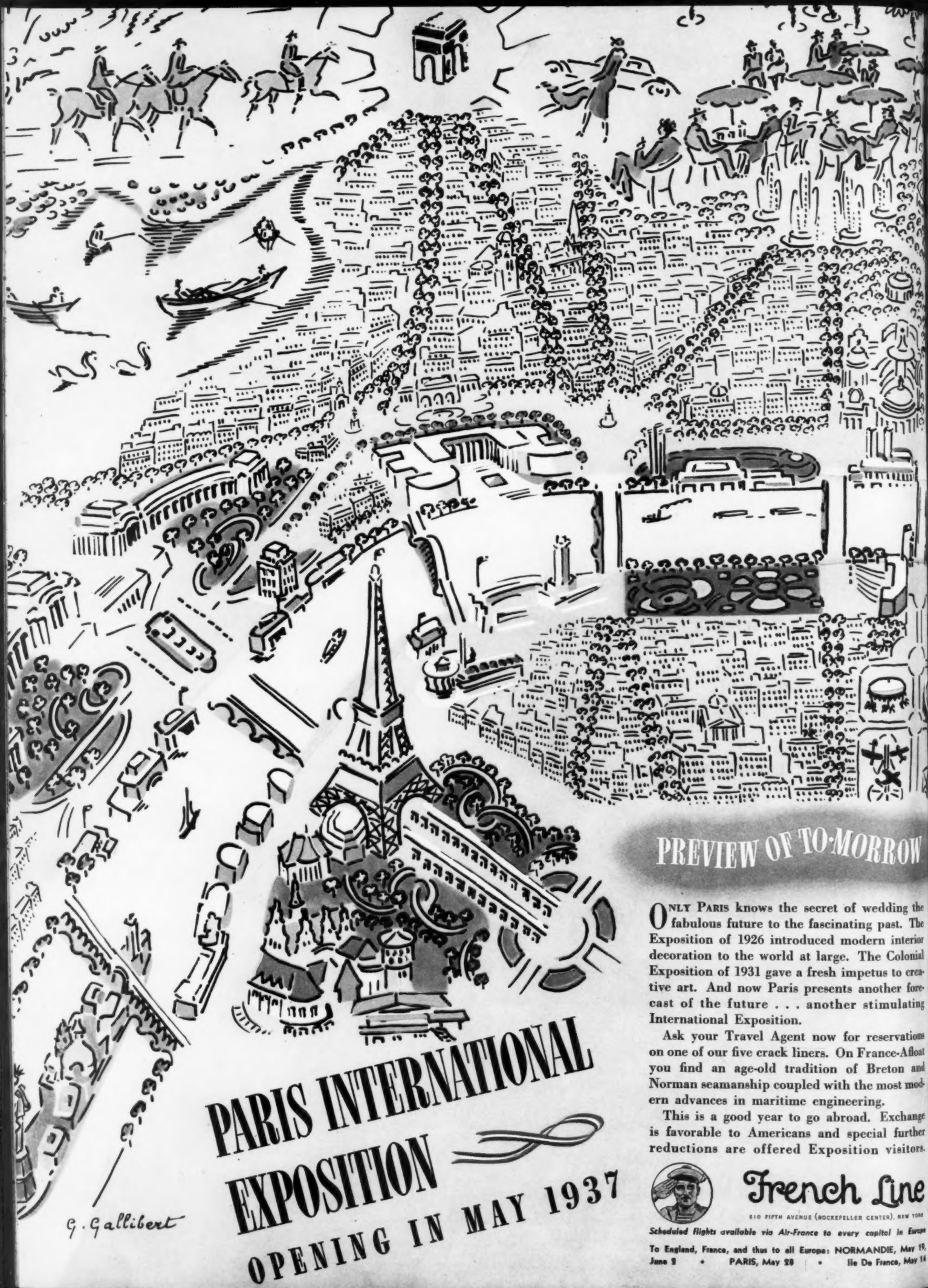

PREVIEW OF TO-MORROW

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(Continued from page 40)

purposes and in particular for tanker construction. This is a steel deriving its properties from the inclusion of small percentages of chromium and copper during manufacture but otherwise produced under ordinary commercial conditions.

Use of small additions of copper in order to produce enhanced corrosion resistance has already been mentioned and it is now pretty well established that small percentages of this element up to from 0.3 percent to 0.5 percent when added to mild steel confer a considerable degree of immunity to corrosion of the kind occurring in steel exposed to the atmosphere of an industrial district. Copper-bearing steel, as it is generally called, is of considerable value for such purposes as the manufacture of roofing sheets. Increased resistance to marine corrosion of the order of 20 percent has been claimed for steel of this type but here the evidence is somewhat conflicting and it seems very doubtful if the somewhat problematical advantage gained justifies the extra cost of plain copper bearing mild steel for shipbuilding purposes.

Other methods of dealing with the corrosion problem, however, have been found to give more positive results. Chromium, well known as the basis of "stainless" steels in which it is used in percentages as high as 14 percent to 18 percent, can be effective as a corrosion resisting agent in very much smaller proportions when in association with copper. Steel containing about one percent of chromium together with from 0.25 percent to 0.50 percent of copper has been demonstrated to have almost double the resistance to corrosion shown by mild steel. Such a steel is not of course in any sense a "stainless" steel nor does inclusion of so small a percentage of chromium call for any special treatment in manufacture or use or add very greatly to the cost.

Steels of this chromium copper type are manufactured under various names and specifications in America and on the European Continent. In Great Britain a chromium-copper steel has been developed under British Patent No. 386463, with which most successful results are being obtained. This steel has the following analysis:—

Chromium	0.70 to 1.10 percent
Copper	0.25 to 0.50 percent
Manganese	0.70 to 1.00 percent
Carbon	not exceeding 0.30 percent
Silicon	not exceeding 0.20 percent
Sulphur	not exceeding 0.05 percent
Phosphorus	not exceeding 0.05 percent

Broadly speaking this analysis corresponds to a mild steel with the addition of chromium and copper. Inclusion of these two elements produces a considerable degree of resistance to marine corrosion and extensive laboratory and practical tests have been carried out by the makers and by users to demonstrate this.

A test carried out on specimens exposed at mean tide level in river water gave results which are shown graphically below. In this test specimens of mild steel and chromium-copper steel were immersed as received from the rolling mills and were removed at intervals of three months when they were dried, brushed, weighed and replaced. This treatment did not wholly remove the hard products of corrosion and at 15 months electrolytic stripping by anode treatment in a cyanide bath was resorted to. This change in treatment is reflected in the change of slope of the curves. Loss in weight of the mild steel specimens is some 50 percent greater than in the case of the chromium-copper steel specimens. This test has been going on now for over two years and continues to show a satisfactory margin in favor of chromium-copper steel. The river water where the tests were carried out is tidal, being approximately half salt in character and very much contaminated with sewage and works' effluent so that this test is of considerable severity.

Other specimens of mild and chromium-copper steel after twelve months immersion show very clearly the characteristic and striking difference in appearance of the surfaces of the two steels after being subjected to corrosive conditions. Not only is total loss very much less in the case of chromium-copper steel but, what is perhaps even more important from the users' point of view, there is a marked absence of deep pitting such as occurs in mild steel specimens. These specimens were also immersed in the river at mean tide level but were left undisturbed for the full period of twelve months after which the products of corrosion were removed by the electrolytic method and the loss in weight obtained. For these and two other similar specimens this was found to be:—

	1	2	
Chromium-copper steel	59.40	60.64	grams per square foot of surface.
Mild Steel	120.46	121.04	grams per square foot of surface.

Again mild steel has suffered double the loss sustained by chromium-copper steel. Figures of this order could be quoted from numerous other tests for the results obtained are most consistent, and it is not surprising therefore that experience in use confirms most fully the correctness of the claims made for chromium-copper steel.

These excellent corrosion resisting properties are however to some extent to be regarded as incidental as the effect of chromium addition on the purely physical properties of the steel is equally marked. Tensile strength rises to the range 37 to 43 tons per square inch and in the case of chromium-copper is associated with the following additional specified properties on material ½-inch in thickness.

Yield Point	23 tons per square inch.
Elongation on 8 inches	17 percent minimum.
Reduction of area	40 percent minimum.

For material over ½-inch in thickness these figures are of course subject to modification on the lines permitted by current specifications.

Comparative micro-structures of chromium-copper and mild steel are shown on page 40 in the as rolled and normalized conditions. Chromium-copper steel derives most of its advantages from the fact that ferrite areas contain alloyed elements which increase the strength of these areas irrespective of carbon content and in a more effective manner. Also the main pearlite areas are more diffused and occupy a larger area than those in ordinary steel of the same carbon content and the ferrite areas show less tendency to banding in the as rolled state. These characteristics are conducive to improved physical properties and greater regularity of the steel.

A 1,250-ton testing machine at Middlesbrough, England, has been used for many tests of this type and is capable of handling tension or compression specimens up to 50 ft. in length and as large as 3 ft. 9 ins. square in cross section. Bend test specimens can be accommodated up to a span of 20 ft. In all cases the full capacity of the machine of 1,250 tons is available.

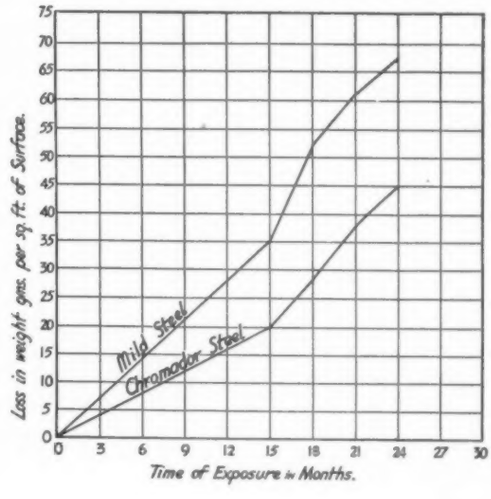
Facilities for testing full scale specimens have enabled a great deal of valuable research to be done on the comparative strength of the new steel and has amply demonstrated the correctness of adopting a working stress 50 percent in excess of that used for mild steel. This high figure is generally employed in designing structures intended to be carried out in chromium-copper steel.

The special case of struts, in which the proportion of length to least radius of gyration is a controlling factor, has been most carefully investigated and tables and curves have been compiled, setting out the appropriate strength relationships.

There is perhaps more difficulty in assessing the precise strength relationship to be adopted in the case of ship design since questions of deflection and stiffness of large panels of comparatively thin plating have to be very carefully considered. None the less, important economies of material are made possible with resulting saving in weight of hull structure.

At this point it should be made clear that there is nothing of an experimental nature about this chromium-copper steel which, in fact, is in regular and continuous production

Comparative loss in weight of quarter inch thick plates tested.



in all the makers' usual rollings of plates and sectional material. Authorities such as the British Board of Trade, London County Council; Lloyds Register of Shipping, British Corporation Register of Shipping and Aircraft, and Bureau Veritas have all given it their approval for constructional and shipbuilding work carried out under their regulations or survey and permit substantial increases in working stresses or reductions in scantlings to be made in recognition of the superior physical properties of the steel.

As a shipbuilding material, the corrosion resisting properties of the chromium-copper steel recommend it to the attention of all responsible for the construction and maintenance of shipping in general and tanker tonnage in particular. It is understood that several important tanker operators are examining the behavior of this steel from the corrosion point of view by practical tests under service conditions and the results of these tests should prove interesting. Owners of ordinary cargo tonnage have found it worth while to incorporate the new steel in those parts of their ships most subject to attack, thereby attaining the desired margin against corrosion without addition of useless weight to the hull structure involved in the usual procedure of specifying increases in plating thickness of 20 percent or so above registration society requirements.

Considerable use has also been made of the new steel in construction of vessels trading in tropical waters under conditions which induce extremely rapid deterioration of mild steel under water shell plating. Results have been very satisfactory following the adoption of chromium-copper steel for shell and deck plating and the fact that owners who have taken this step continue to specify the new steel for an increasing proportion of the structure of succeeding new ships speaks for itself.

Application of a steel such as this to craft of special type need not be more than mentioned. Chromium-copper steel is being used to a greater or less extent in the construction of salvage tugs, light-ships, barges carrying petroleum, bitumen, sugar cane and other cargoes and for high-speed coastal patrol cruisers. In some cases, notably that of the patrol cruisers, the entire hull structure, framing and plating, was carried out in chromium-copper steel with chromium-copper type rivets and extensive use of electric welding, for which this steel is quite suitable.

Altogether the new steel has been incorporated in construction of vessels ranging from barges and harbor craft to cargo steamers of 9,000 tons deadweight and upwards in addition to the large tonnage which has been used for general constructional purposes, bridge building, locomotives, railway rolling stock, gas works plant and a variety of other uses calling for a high degree of resistance to corrosion and abrasion combined with maximum strength and minimum weight.

In no case has any difficulty been found in carrying out usual shipyard and constructional operations customary in fabrication of the more familiar mild steel such as punching, shearing, joggling, etc., nor has any trouble been experienced in use of the special rivets which have been extensively employed and found entirely satisfactory driven either by hand or by pneumatic or hydraulic machine.

These rivets are manufactured from a similar steel but of about five tons per square inch lower tensile strength. It is found that the tenacity of the rivet is raised by this amount due to the work done on the steel in driving. The rivets, of course, have the same good resistance to corrosion possessed by the parent metal.

Use of electric welding with chromium-copper steel has already been mentioned and a great deal of work has been fabricated by this method with entire success both in the shipyard and elsewhere.

In numerous instances chromium-copper steel has been used alongside ordinary mild steel and there is no objection to this procedure so long as the various members are correctly proportioned to the work they have to do and experience has shown that neither material is adversely affected so far as corrosion is concerned.

To sum up, chromium-copper steel retains the well known advantages of mild steel with regard to workability and suitability for general use, having in addition greatly enhanced resistance to corrosion and abrasion and 50 percent greater strength together with the guarantee, implicit in all special steels, of a high and uniform standard of care in manufacture.

It is understood that the cost of chromium-copper steel is, per ton, about 25 percent above that of mild steel but this would of course be largely offset by economy in tonnage resulting from use of the stronger and more resistant steel.

Considering the possibilities suggested by the adoption of this type of steel for oil tanker construction, it would seem that the customary longitudinal framing system is peculiarly suitable for most economical use of a high tensile steel and on a reasonably conservative basis it should be possible, by employing chromium-copper steel throughout the entire structure, to reduce the steel weight by at least 10 percent to 15 percent. This would represent a saving of from 300 to 500 tons in the case of a modern ocean going tanker of 10,000 to 12,000 tons deadweight.

It is suggested also that much of the trouble experienced with bracket connections and leaky rivets might be overcome by the use of this steel which not only has a high specified yield point, 23 tons per square inch, but also has a proportionately high resistance to alternating stress or fatigue in the order of 1.5 times that of good quality mild steel.

With regard to corrosion, mention was made, at an earlier stage, of the use of plain copper-bearing steel for corrosion resisting reasons and it is believed that this material has been tried for oil tanker plating but without any great success. This is only what might have been anticipated from an examination of the experimental work carried out. Circumstances attending corrosion of steel plates at sea differ greatly from those operative in the case of corrosive industrial atmospheres in which copper-bearing mild steel is to some extent effective and it is just in these marine conditions that the effect of the introduction of chromium with copper is most evident. There is every reason to suppose that the superiority shown by chromium-copper steel over mild and plain copper-bearing steels when used in vessels of other types and trades would equally, in the case of bulk oil carriers, go far to resist the extremely rapid attack to which so many of these vessels are subject and would materially prolong the life of the tankage and minimize upkeep and repair costs.

Much of the severe corrosion occurring in tankers is attributed to presence of sulphurous matter in the tanks and to consequent formation of free warm acid during the periodical steaming out process and it is interesting to note that in the case of gasworks plant, where similar conditions exist, aggravated by considerably higher temperatures and the abrasive action of wet coke, chromium-copper steel has been found most effective in resisting attack and has practically double the life of the mild steel formerly used.

If full advantage be taken of the greater strength of the chromium-copper steel to obtain, by careful design, most efficient and economical use of the material, increased cost per ton of the higher grade steel would show very little effect on total cost of the ship and would, it is submitted, be greatly outweighed by the advantages inherent in use of a steel having the properties outlined above.

World's largest universal testing machine, capacity 1,250 tons.

U. S. OIL EXPORTS May Reach $300,000,000 in 1937

THE trend in value of petroleum and product exports from the United States established between 1935 and 1936 appears to be continuing at an accelerated rate during the opening months of 1937. In 1935 the average monthly value of petroleum exports was $20,759,000; by 1936 the average monthly value of petroleum exports had increased to $21,737,000; during the first two months of 1937 the average value of petroleum exports had jumped to $23,715,000 or almost double the increase between 1935 and 1936. This increase is notable especially in view of the fact that during recent years, monthly exports have been at their lowest point during the early part of the year. If the same seasonal cycle prevails during the present year, and if the rate of exports keeps up to its present indication, the year should come close to a record for the value of petroleum and products exported.

The seasonal cycle in petroleum exports during the past two years has shown a marked dip at the beginning of the year, reaching its lowest point in both years during the month of February. From that point exports have shown a steady rise until the middle of summer when they have reached a peak, declining in the late fall and early winter.

During 1935 the total value of oil exports was $249,104,000. In 1936 the total value of oil exports reached the figure of $260,845,000. On the basis of present indications there is a good possibility that the value of petroleum exports during 1937 may exceed $300,000,000.

Petroleum and products rank as the second largest classification exported from the United States, being exceeded only by unmanufactured cotton. In terms of dollar value, exports from the United States rank as indicated in the accompanying table.

On the other hand petroleum and products rank but 23rd amongst United States imports and consist largely of crude oil.

In tracing the course of petroleum exports by products over the past two years it will be noticed that crude oil constituted the most valuable classification of petroleum products exported during 1936 when 50,320,000 bbl. of crude valued at $66,142,896 were exported. In 1935 a greater quantity—51,430,051 bbl. of crude—had been exported but the value of crude oil exported in 1935 was less than that exported in 1936, being $61,176,235. Of petroleum products, the most important export in point of value in 1936 was lubricating oil when 9,104,980 bbl. valued at $64,551,634 were shipped abroad. In 1935 the most valuable export among the petroleum products was gasoline, some 26,720,000 bbl. valued at $63,716,227 having been exported.

The average monthly value of crude oil exported during 1935 was $5,098,000 while during 1936 it increased to $5,512,000. During the first two months of 1937, which, it must be remembered, represent a seasonally slack time for exports, the average monthly value of crude oil exported from the United States was $5,035,000. Possibly due to the decreased emphasis on national refining programs established by some European countries, the value and quantity of crude oil exports showed a slightly decreasing trend while the value of gasoline exports showed a marked increase. The long-term national refining programs were neglected in favor of acquiring at once large storage of gasoline as a safeguard in event of immediate war. The value of gasoline exports per month on the average in 1935 was $5,309,000 decreasing to $5,173,000 in 1936 and moving up sharply to $5,472,000 per month for the first two months of 1937. Gasoline exports exactly reversed the trend of crude oil exports for these three periods.

The figure for the value of lubricating oil exports in 1936 has already been given as $64,551,634, or $5,379,000 average per month, against $5,196,000 average value per month in 1935. These figures compare with $5,951,000 per month for the first two months of 1937. The increase in the monthly value of lubricating oils reflects not only the increased value of all petroleum products at the point of manufacture but also the greater industrial activity in the countries of destination.

Elsewhere in this article is presented a table showing the quantity and value of petroleum products exported from the United States during 1935 and 1936 by products, ranked in order of their importance during 1936. It should be noted that bunkers, although included in this table, are not classed as exports. Hence the value of exports given above should only be compared with the accompanying table after deducting the value of bunker oils.

Value of U. S. Exports in Order of Importance 1936

Classification	Dollars
Unmanufactured Cotton	$361,043,000
Petroleum and Products	260,845,000
Leaf Tobacco	136,669,000
Electrical Machinery	91,345,000
Coal and Coke	56,572,000
Iron and Steel Plates	49,639,000
Agricultural Machinery	43,993,000
Metal Working Machinery	41,897,000
Refined Copper	40,702,000
Boards, Planks and Scantlings	36,830,000
Aircraft	23,056,000
Cotton Cloth	21,874,000
Iron and Steel Scrap	21,766,000
Photographic and Projection Goods	20,856,000
Books, Maps, Pictures, etc.	19,930,000
Well and Refinery Machinery	19,253,000

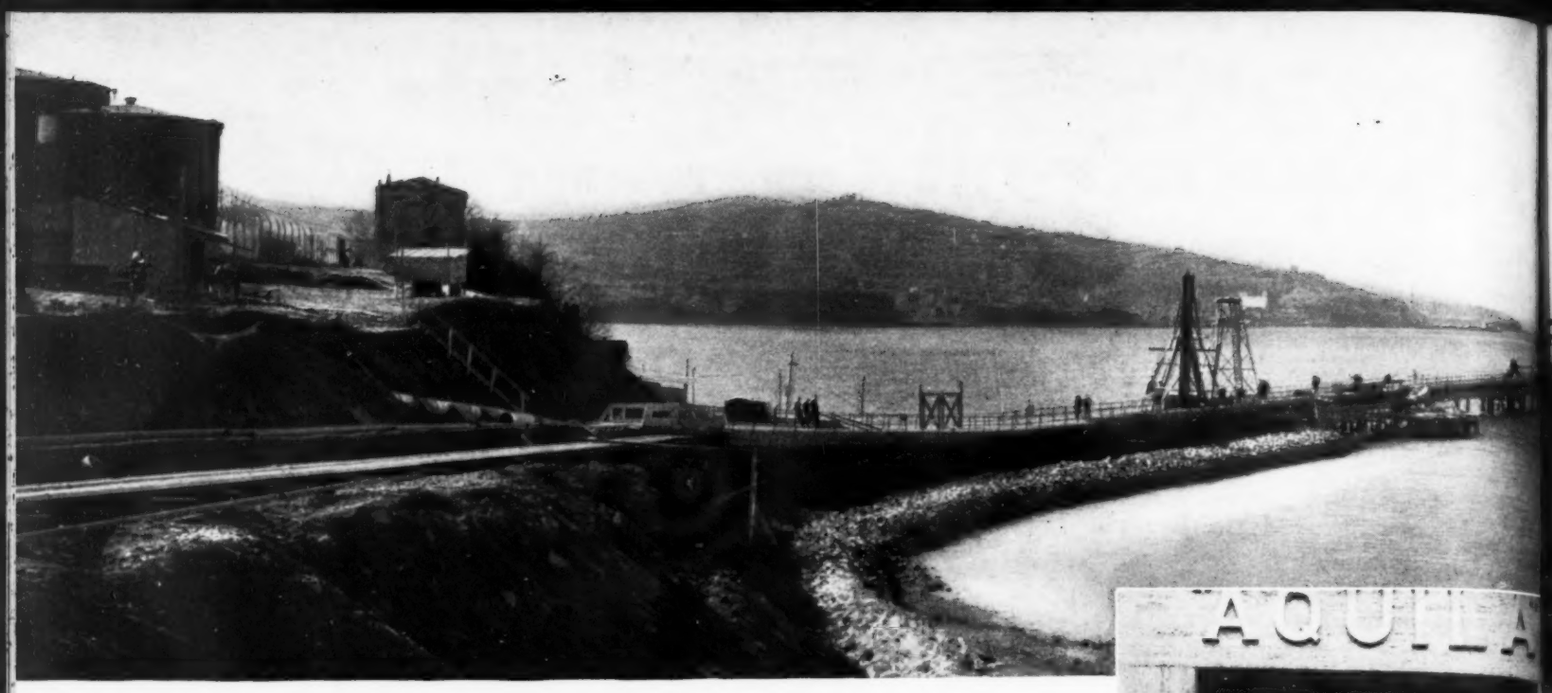
Imports of crude oil have increased in quantity and value between 1935 and 1936 and the same situation holds as regards imports of refined products. Some 30,555,045 bbl. of crude oil were imported in 1936 against 25,545,533 bbl. in 1935. The value of the crude imported during 1936 was $21,721,610 against $18,021,858 for the previous year. Refined imports increased from 22,200,684 bbl. valued at $13,293,337 in 1935 to 25,330,596 bbl. valued at $16,413,354 in 1936. In comparing petroleum exports and imports it should be noticed that while the value of all petroleum imports increased 21.7 percent between 1935 and 1936, the value of all petroleum exports increased only 4.7 percent. However, the United States

(Continued on page 58)

U. S. Petroleum Exports in Quantity and Value

	1936 Quantity (bbl.)	1936 Value ($)	1935 Quantity (bbl.)	1935 Value ($)
Crude	50,320,634	66,142,869	51,430,051	61,176,235
Lubricating oil	9,104,980	64,551,634	8,351,414	62,357,813
Gasoline	24,066,853	62,076,333	26,720,625	63,716,227
Bunkers	33,406,657	34,298,414*	30,303,731	29,924,908*
Gas Oil & Distillate	18,329,012	23,674,884	14,350,563	17,483,804
Kerosene	6,708,640	14,816,777	6,455,279	15,148,753
Residual fuel oil	12,955,357	11,243,598	11,334,374	9,568,695
Natural gasoline	1,896,779	4,203,682	1,644,905	3,335,091
	(lbs.)		(lbs.)	
Paraffin wax	187,278,689	5,961,640	230,118,047	7,624,989
Lubricating grease	88,841,957	3,901,466	94,552,132	4,002,447
	(tons)		(tons)	
Asphalt	170,094	2,835,173	198,951	3,370,559
Petroleum coke	111,231	1,078,502	119,228	916,113
Total value		295,143,725		279,028,534

* Value of bunkers should not be included in the annual value of petroleum exports.



Discharging the first cargo of crude oil at the Aquila refinery in Italy. Below, left, President of the company, Comm. Gino Alessi, and right, Dr. Franz Kind, managing director.

AQUILA

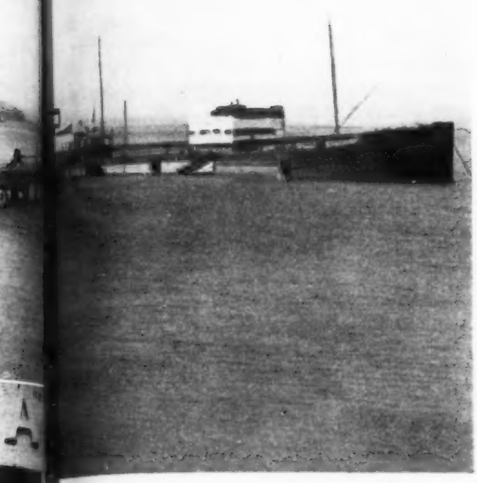
Italy's Most Up to Date Refinery, Located at Trieste and Recently Completed

TRIESTE—important Mediterranean seaport since the Roman Empire—is the site of Italy's newest and most up-to-date refinery. Advantageous from the point of Italian economic policy this plant recently erected by "Aquila" S. A. Tecnico-Industriale enjoys the advantage of being the nearest water base for territories lying between the Danube on one side and Mediterranean Sea on the other, the hinterland which forms beyond the Italian frontier making it a natural outlet for the most varied products, while as a shipping and industrial center it is excellently situated both with regard to indigenous markets and those outside Italy.

"Aquila" is an operator entirely new to the industry, although certain of the officials have had wide experience in the oil business. It was formed in July, 1934, through the untiring efforts of Dr. Franz Kind, who negotiated the concession and has been so active in its technical development. Dr. Kind is general manager and a board member of the new company. He is also managing director of the Redaventza refinery at Antwerp, construction of which he directed. The president of "Aquila" is Comm. Gino Alessi, while the three managers are Dr. S. Albonetti, Dr. G. Buldrini and Dr. E. Monti. The company's board comprises: Gr. Uff. Prof. Dott. Carlo Anti, Gr. Uff. Avv. Camillo Ara, Comm. Ing. Gino Coen, Gr. Uff. Cap. Antonio Cosulich, Dr. Walther von Fischel, Albert Flegenheimer, Dr. Theodor Frank, Gr. Uff. Dott. Ernesto Mittler, Comm. Ettore Modiano, Gr. Uff. Dott. Leonardo Montesi, Cav. di Gr. Cr. Elario Montesi, Comm. Enrico Paolo Salem, Conte Comm. Avv. Piergiovanni Ricci-Crisolini, Gr. Uff. Dott. Guido Segre, Comm. Ing. Diego Soria, Emil Georg von Stauss, and Conte Gr. Uff. Dott. Mario Tripcovich Dott. Carl. Ernst Sippel.

The new refinery is an important cog in the wheel of Italy's self-sufficiency machine and is the most important on the Mediterranean, having a capacity sufficient to provide more than 20 percent of the country's fuel oil and motor spirit demands and over 50 percent of the lubricating oil products consumed. Apart from the quantities reserved for home consumption in accordance with the policy of the Italian Government in the mineral oil field, the "Aquila" refinery has drawn up a large program for deliveries of petrol, kerosene and gas oil, as well as for other light products, bunker oil for navigation, and—last, but not least—for high grade lubricants and special oils of the most varied kinds. These have been up to now imported mainly into central Europe, the Balkan and Mediterranean cou tries from Hamburg and Belgian refineries, as well as from American export shippers. It is the first plant in the country to supply the export trade and it is hoped to revive the bunkering business in that section of Italy.

The Minister of Finance granted the concession for the erection of a refinery of a capacity of 300,000 to 350,000 tons in July 1935; by a 20 years' license half of the production was foreseen for home consumption, whilst the other half was reserved to export business, respectively for bunkering of ships. The conception of the export business was essentially under the influence of the "patto tripartito" (Three Parties' Pact),



aiming at the establishment of a specially intimate economical connection with the hinterland of Trieste, to which territory belong substantially Austria and Hungary.

The fact that the concession was given to an undertaking as "Aquila" that is completely independent of the world trusts and at which—as shown in the list of the Members of the Board of the Company as stated earlier in this article—important factors of the national Italian and shipping companies are interested, represents the first stage of the realization of Italian petroleum legislation, which foresees such a development of its refining industry until the year 1939 that Italy will become practically independent of importation of finished products, importing thus only crudes. It is natural that the erection of the "Aquila" Refinery should incorporate extraordinary flexibility both regarding the possibilities of the refining of crudes of various origins and the necessities of the Italian and the nearest export markets; the fact that special consideration was given to attain the highest technical efficiency and a minimum of loss in production does not need to be specially mentioned.

The well-known petroleum engineers and technologists, Moore & George Ltd., were consultants for the building of the refinery. Harold Moore, genial and energetic partner in the concern, kept in close contact with all stages of construction by making numerous trips to Trieste. H. E. Charlton was resident engineer in charge of planning, designing and erection of the installation.

Actual construction was commenced in March 1936, when the first excavation for storage tanks and foundations was started; work was continued throughout the year, between 1,500 and 2,000 men being constantly employed. Official opening by the Duke of Aosta took place January last, and the refinery is now turning out a variety of first-class products, including lubricating oils. It has a throughput of from 300,000 tons to 350,000 tons of crude oil per annum, or nearly 7,000 bbl. per diem.

The refinery covers an area of about 28½ acres and there is the possibility to extend considerably as the company owns an additional 71½ acres of adjoining land. The site is some eight kilometres from Trieste, on a hillside at the end of the Bay of Muggia, which forms a natural harbor for accommodation of tankers. Vessels of any size up to the largest bulk-oil carrier afloat can be berthed with ease and safety at the jetty, which is of reinforced concrete and terminates with a platform for accommodation of the flexible hose used for making connections from ship to shore; safety of the jetty is ensured by means of wooden dolphins and buoys. The depth of water at low tide is 9½ m., or about 31 feet. The jetty carries two 8-in. pipes, three of 4-in. diameter, and three of 2-in. size; these serve for the various oils and for services such as steam, air and water. Provision is also made to load lighters and barges alongside the jetty, and small craft up to 1,000 tons capacity can be seen daily being loaded with finished products from the refinery.

Storage capacity totals about 100,000 tons and the two largest tanks have a capacity of 12,500 tons of crude oil each. Total crude storage capacity is for 35,000 tons. The tanks are situated on the hillside, at a height of about 100 ft. above sea level, on the upper side of the main road which divides this tank farm from the main plant. Communication from tank farm to refinery is by means of a tunnel underneath the road, which serves not only for the pipelines but also for the company's personnel. Gasoline is stored in tanks fitted with Wiggins floating roofs in order to prevent as much as possible the exceptional evaporation losses which would otherwise be incurred due to the great difference between night and day temperatures in the hot climate of Italy.

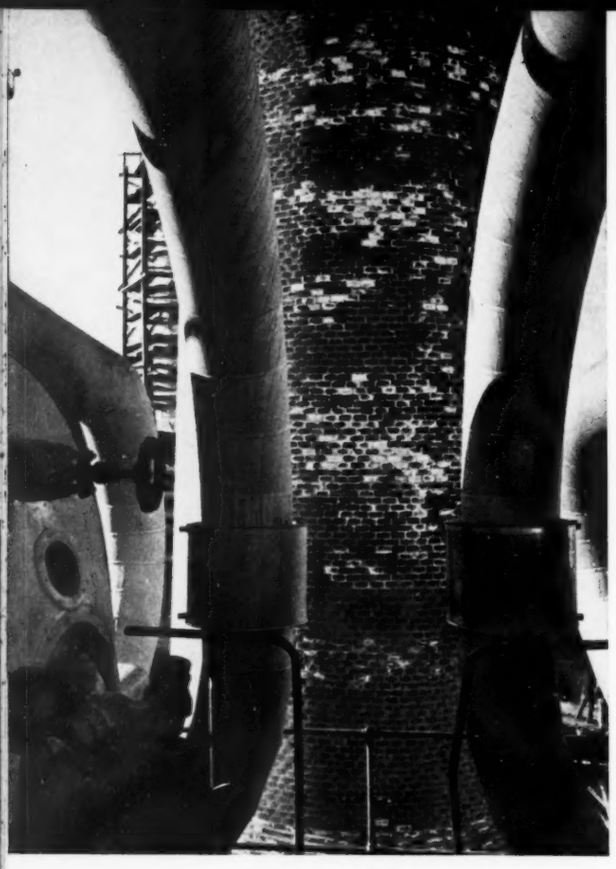
Tankers have no difficulty in pumping crude into storage despite the long line and appreciable head, although with exceptionally viscous crudes provision is made for the pumps of the central pump house to assist ships' pumps by being put in series as boosters if necessary.

All lines from the jetty pass through the central pump house, where also every tank and every plant has its own separate line or lines, ending in an exchange pit where connections are made with flexible hoses in order to make the necessary transfers of liquid. Although this pump house is equipped with six large and two small pumps, many of these transfers are effected by gravity. With this method of flexible hoses contamination of products is absolutely impossible, and as many of the pumping operations are repeated daily, or are sometimes even continuous, many of the connections are left undisturbed for long periods and the system works very efficiently and quickly.

Due to the elevation and arrangement of the storage tanks above the level of the jetty, filling tanks, and loading racks, almost all of the deliveries of the light non-viscous products can be made by gravity and tankers of gasoline can be loaded in this way at the rate of 150 tons per hour when the tanks are full and 100 tons per hour when they are nearly empty. In fact, gravity has been exploited to the fullest possible extent in the new refinery to facilitate normal movements of liquids and to keep the running costs at a minimum.

From storage the crude flows to the two-stage distillation plant, which has the ability to process approximately 1,000 tons of crude per day through the atmospheric section and 350 to 500 tons of atmospheric residue (from crudes suitable for making lubricating oils or asphalt) through the vacuum section. This unit designed by Foster Wheeler Ltd. and constructed and erected by Borsig, is one of the most modern type and has an exceptional range of flexibility. The atmospheric section can work on crudes having up to 50 percent of overhead gasoline or having 50 percent of bottoms, and on the vacuum section the residue can be from less than 10 percent up to 75 percent of the

The Edeleanu plant for the production of lubricating oils. The central figure in the group is H.R.H. the Duke d'Aosta, with the Minister of Corporations, H. E. Ferruccio Lantini on his right.



Partial view of the Foster Wheeler distillation plant.

vacuum charge, thus having the possibility of making first-class asphalts in large quantities from suitable crudes.

The atmospheric section has pressure settlers in order to eliminate water and solid matter from the crude; from these settlers the crude is pumped into one of the banks of tubes in the convection section of the furnace and then under pressure into the predistillation tower where all the corrosive gases are taken off with the light gasoline, without steam. From the bottom of the predistillation tower the crude passes again into the furnace and then into the atmospheric tower, where gasoline, white spirit, kerosene, gas oil and residue are obtained. Fractionation is such that between the gasoline, white spirit and kerosene, there is no overlap between the end boiling point of one product and the initial boiling point of the next. In fact, in practice a few degrees gap has been obtained.

Residue from the atmospheric unit can either be pumped to the fuel oil storage or, when the crude is a suitable one for the manufacture of lubricating oils, to the vacuum section. From the vacuum unit one overhead stream of heavy gas oil and sidestreams of lube oils are obtained in addition to the asphaltic residue.

The atmospheric and vacuum unit are arranged so that they can work in series or in parallel, in the latter case a topped crude could be charged to the vacuum unit differing from the residue coming from the atmospheric section, which part of the plant is then free to work completely independently on another crude. This unit has a very complete system of entirely automatic control.

Products leaving the distillation plant flow to run-down tanks of 100 tons capacity each, of which there are 20, where they are taken continuously by the chemical treatment plant, or are pumped away to finished storage. The chemical treatment plant is designed and constructed after the patents of Moore & George Ltd., and has already proved itself to be an unqualified success, having worked continuously for many weeks, and is of an exceptional flexibility. With the 12 special mixers, settlers and chemical pumps, five separate products can be treated simultaneously and automatically. Injection and measurement of chemicals is effected regularly and accurately by means of proportiometer pumps—particularly indicated for this type of continuous treating circuit. Gasoline, white spirit, kerosene and lubricating oils are treated in this plant with sulphuric acid and alkali or other reagents, according to the indications and instructions of the laboratory. Treatment effected in this plant gives consistent economic results and running costs are very low for only one operator and two assistants are needed to control the process when working simultaneously five different products.

Lubricating oils from the vacuum section of the distillation plant go to storage, from whence they are taken separately to the combined Edeleanu solvent and dewaxing plant and undergo there a process of solvent extraction and dewaxing with a mixture of SO_2 and benzol as the solvent, and SO_2 alone as refrigerant. This plant, which has just been put into operation and has a capacity of 100 tons per day, was designed by Edeleanu Gesellschaft and constructed by Borsig. Oils from the Edeleanu plant can either be delivered direct to finished storage or they can pass through the filtration plant where they are further treated with activated earth. There is also the possibility of taking these oils to the chemical treatment plant, when special products are required, as in case of transformer or white oils, which oils will form an important part in the production programme of "Aquila." After the finished storage, the products are delivered to the loading departments, where there are very adequate rail and road loading facilities.

The water system for the condensers and coolers of the distillation and Edeleanu plants is a very complete one, designed to give the maximum security at all times. Demand for water for this purpose varies from some 400 tons in winter to 1,200 tons per hour in summer. Normal supply is taken from the sea by means of four motor-driven centrifugal pumps installed on a concrete platform at a point about half way along the jetty, where the depth of water is from 3½ to 4 m. These may be started from the central station control room, which is about 600 m. away and in addition the capacity of each pump can be varied independently by means of motor-operated delivery valves, situated on the outlet of each pump. Priming of these pumps is effected by means of a vacuum pump, also controlled from a distance. Magnetically operated valves automatically connect the vacuum pump to whichever pump is started in order to suck up the water into the pump. When the pump is primed and a pressure is generated in the pump a pressure-operated switch closes the vacuum line and the vacuum pump can then be stopped. Apart from the great convenience of being able to conduct all these operations from a central point, another advantage of this method is that the pumps are actually started without water so that starting shock to the electrical system is greatly reduced. By virtue of this ingenious arrangement it is not necessary to make more than a weekly inspection of the water pumping plant.

Asphalt from the vacuum unit is pumped directly to the asphalt storage tank which is situated near the space allocated for the filling of barrels, rail and road cars. There are some 950 m. of rail sidings belonging to "Aquila," with a loading rack which at the moment is arranged for loading 12 waggons simultaneously and which can be extended to double this capacity if the need arises. Loading of road cars is effected underneath a bridge, which spans (without any intermediate supports) the whole loading platform, and which has a width of 25 meters, thus giving a free space for movement of the vehicles. Outgoing waggons and tank cars are weighed on weigh-bridges, placed at the entrance.

Large areas are reserved for the buildings

Panoramic view of the recently completed Aquila S. A. plant on Trieste Bay, Italy. The refinery has an annual capacity of 300,000 tons to manufacture a complete line of products.

where barrel, drum and can-filling will be carried out. In the filling department for lubricating oils provision will be made for blending and clarifying of finished lubricants immediately before they are delivered. Along the whole length of two sides of this building is installed a slightly elevated platform which facilitates loading of barrels onto waggons and trucks.

Boiler plant and central power station is situated almost in the centre of the refinery and from this point almost all of the services can be controlled. The two boilers which are situated in the open were made by Borsig and are of the water tubular type with side wall tubes, and each has a full load evaporation of 12 tons of steam per hour at 300 lbs. per sq. in. pressure. Advantage is taken of the expansion of steam from 300 lbs. down to 120 lbs per sq. in. (which is the pressure of the general steam line for pumps, etc.) in order to generate in back pressure steam engines, coupled to alternators, a reserve supply (up to 150 k.w.) of electrical energy at a low cost.

Electrical and steam compressors situated in the same engine room supply the compressed air required in the refinery.

All the switching operations of the high tension transformer station are controlled from the central power station. The transformer cabin is situated on the opposite side of the road, some 200 m. away and transforms the energy received from the supply company at 26,000 volts down to 500 volts, and has three transformers with a total capacity of 900 k.v.a., with one cell as provision for a future transformer. Distribution of all the electrical energy at 500 volts, both from the supply company and also that from the reserve alternators, is made in the central power station, where a most complete and modern switchboard is installed, with all the necessary instruments for the control and measurement of all the refinery services.

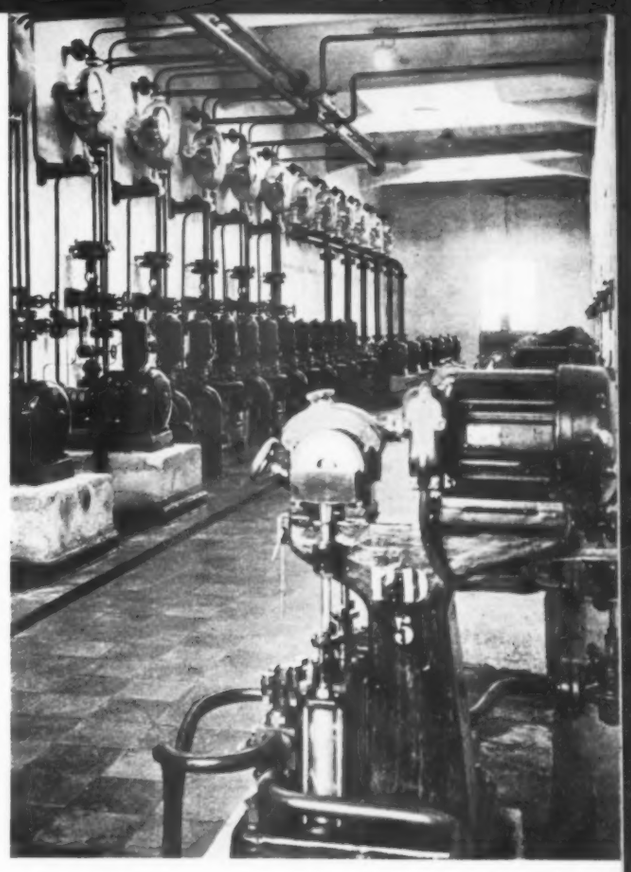
A reserve supply of fresh water is at all time available from a concrete reservoir situated at the highest point on the hill above the refinery, containing approximately 2,000 tons of water. An alarm system gives warning when pressure on the sea water-line falls below a certain predetermined value, so that the operator can immediately open the fresh water valve.

A very modern and well equipped laboratory situated in a central position and directed by Dr. Herzenberg controls the quality of all products as they pass through the various processes.

One of the largest contractors of the refinery was "Aquila" itself, for all the pipe work, erection of pumps and machinery, all the electrical work, and in addition a large amount of excavation and building work, including the laying of over a kilometre of railway sidings, was executed by direct labor under control of the company's engineering staff, directed by Mr. Charlton, and in this work some thousands of valves were employed and approximately 65 kilometres of pipelines, over 100 pumps, and well over 15 kilometres of electric cables were installed.

PRINCIPAL CONTRACTORS AND SUPPLIERS

Foster Wheeler distillation plant	Rheinmetall Borsig
Edeleanu plant	Rheinmetall Borsig
Boilers	Rheinmetall Borsig
Filter presses	Wegelin & Huebner
Storage tanks	Cantieri Riuniti dell' Adriatico
Wiggins floating roofs	Cia. Tecnica Industria Petroli (H.S. Bell)
Excavations and buildings, including offices	Buttoraz & Ziffer
Jetty	Societa Anonima Costruzioni Opere Pubbliche
Valves	Schaeffer & Budenberg
Instruments	Siemens C.G.S. Istrumenti di Misura
Pumps	Worthington Weise & Monsky Weise & Soehne
Transformers	G.E.C. Compagnia Generale Elettricita
Motors (Edeleanu plant)	A.E.G. Allgemeine Elektricitaets Gesellsch.



Pump house and control room of the Aquila plant.

Six 250 H.P., 3600 RPM, 2200 volt ball-bearing squirrel-cage induction motors driving oil pipeline pumps in Oklahoma.

ELECTRIC MOTORS FOR PIPELINES

By G. R. Prout
International General Electric Co.

ELECTRIC motors were used to a very limited extent by oil pipeline companies prior to 1926. At that time, however, centrifugal pumps of acceptable efficiency and suitable for handling crude oil under the volume and pressure conditions required by pipeline service appeared on the market. Since the centrifugal pump is a high-speed machine, when handling large volumes at high pressures, it was quite natural that the development of the oil-line centrifugal pump was carried on using the high-speed electric motor as the prime mover.

Electric motors for driving oil-line pumps are now considered fully established as standard drives by the pipeline industry in the United States. The degree of acceptance is evidenced by the fact that there is now installed in pump stations of oil or gasoline pipelines more than 200,000 horsepower of electric motor capacity.

The power companies have transmission lines that cover much of the country through which oil and gasoline pipelines pass, consequently reliable electric service is now available or can readily be made so at almost any proposed location.

Centrifugal pumps for oil or gasoline pipeline pumping service are high-speed machines as was pointed out above. Nearly all of the present day pumps operate at a speed of about 3,550 RPM. These pumps are available with efficiencies from about 72 to 85 percent when handling crude oil in capacities from 20,000 bbl. per day to 75,000 bbl. per day at line pressures of 500 to 900 pounds per square inch. Smaller pumps are also available but their use in present practice is limited more or less to gathering-line service.

Since these pumps operate at high speeds, the electric motor which is normally a high-speed unit combines readily with this type of pump to produce an inexpensive, light weight, efficient pumping unit for pipeline service.

Until the advent of the gasoline pipeline, the constant-speed motor, direct coupled to

the centrifugal pump largely met the requirements of pipeline pumping. Consequently, most of the equipment now in operation is of the constant-speed type. However, variable-speed equipment is now being used to an appreciable extent on gasoline lines.

The simplest type of electric motor is the squirrel-cage induction motor. This machine consists of but four main parts—the stator, the rotating element and two end shields, each of which contains one bearing. This mechanically simple machine has long, trouble-free life and operates with a very low maintenance cost and requires very little labor for its operation.

The mechanical simplicity and sturdy construction of this type of motor, together with its relatively simple control equipment and its low first cost, makes it the most popular type of motor with pipeline operators.

In some cases, particularly where power costs depend somewhat on the power factor of the load, the synchronous motor with direct-connected exciter is being used. This machine, while not quite so simple, mechanically, as the squirrel-cage motor, normally operates at unity or leading power factor. The efficiency of the synchronous motor is usually slightly higher than that of the correspondingly rated squirrel-cage motor, although this difference is usually not in excess of one or two percent. These advantages are obtained at an increased first cost and a somewhat more involved motor which requires an exciter and a control equipment not quite so simple as that required by the squirrel-cage motor. The synchronous motor, where it has been used, however, has been found to be highly satisfactory from the operating standpoint.

Slip-ring induction motors with variable-speed control have been used to drive reciprocating as well as centrifugal pumps where speed variation was required.

In some cases this type of motor with variable-speed control was used with centrifugal pumps to maintain constant, maximum allowable pressure on the line throughout the year. Ordinarily, the pressure maintained at the pump stations on a crude-oil line using centrifugal pumps, drops during the Spring as the temperature increases and the viscosity decreases. The minimum pressure obtains during the Summer months. During the Fall as temperatures again decrease and viscosities increase, the pressure increases until the maximum pressure obtains during the Winter.

Due to the fact that the head-capacity curve of the centrifugal pump is a drooping characteristic, i.e., the volume increases as the pressure decreases, the maximum pumpage is obtained on such a line during the summer months, yet if the pressure on the line could be maintained at maximum allowable the line would handle appreciably more oil.

With this thought in mind several installations were made where the main pumps were driven by constant-speed squirrel-cage motors and on the suction side of each station a full-capacity, low-pressure centrifugal pump, driven by a variable-speed slip-ring motor, was installed. This pump did not operate at all during the Winter. Then as temperatures increased in the Spring, these pumps were started and run at slow speeds. As the temperature increased, as Summer approached, the speed of these pumps was increased until full speed was reached during the Summer. The reverse took place during the Fall until Winter arrived, at which time the auxiliary pumps were shut down. By means of this operation, constant maximum allowable pressure on the line was maintained and maximum annual pumpage obtained. The low-pressure, variable-speed unit supplied that increment of pressure required, which, when added to the pressure of the main pumps, would give that total station pressure which was the maximum safe operating pressure. This was possible, of course, because of the fact that the pressure of a centrifugal pump varies with the square of the speed.

Variable-speed slip-ring motors driving reciprocating pumps have also been used to an appreciable extent on gasoline pipelines to provide a means for varying the volume pumped through the line.

The slip-ring motor is a relatively simple machine mechanically. When used with proper control equipment its speed can be changed over a wide speed range. The efficiency of the motor drops, however, as the speed is reduced by insertion of resistance in the rotor circuit. This drop in efficiency is proportional to the reduction in speed if the torque developed is constant. This condition may obtain when the motor is driving a reciprocating pump. However, in pipeline service on any given line if the volume pumped is decreased by reduction in speed of the pump, the pressure required to pump the reduced volume through the line usually is reduced and the torque required falls as the speed is reduced. Under these conditions, the motor efficiency drops a little more rapidly than the speed, but since the actual power required has also decreased more rapidly than the speed, the motor efficiency is not quite so important as at full speed because the actual power developed is materially less than at full speed.

The power required to drive a centrifugal pump varies as the cube of the speed. Therefore, when a slip-ring motor-driven centrifugal pump is operated at reduced speeds, the power drops off very rapidly. For example, if the speed is reduced 50 percent, the power required is reduced to about 12½ percent of that required at full speed. Therefore, even though the efficiency of the motor drops more rapidly than the speed decreases, the actual losses in the motor are relatively small because the power required is so small.

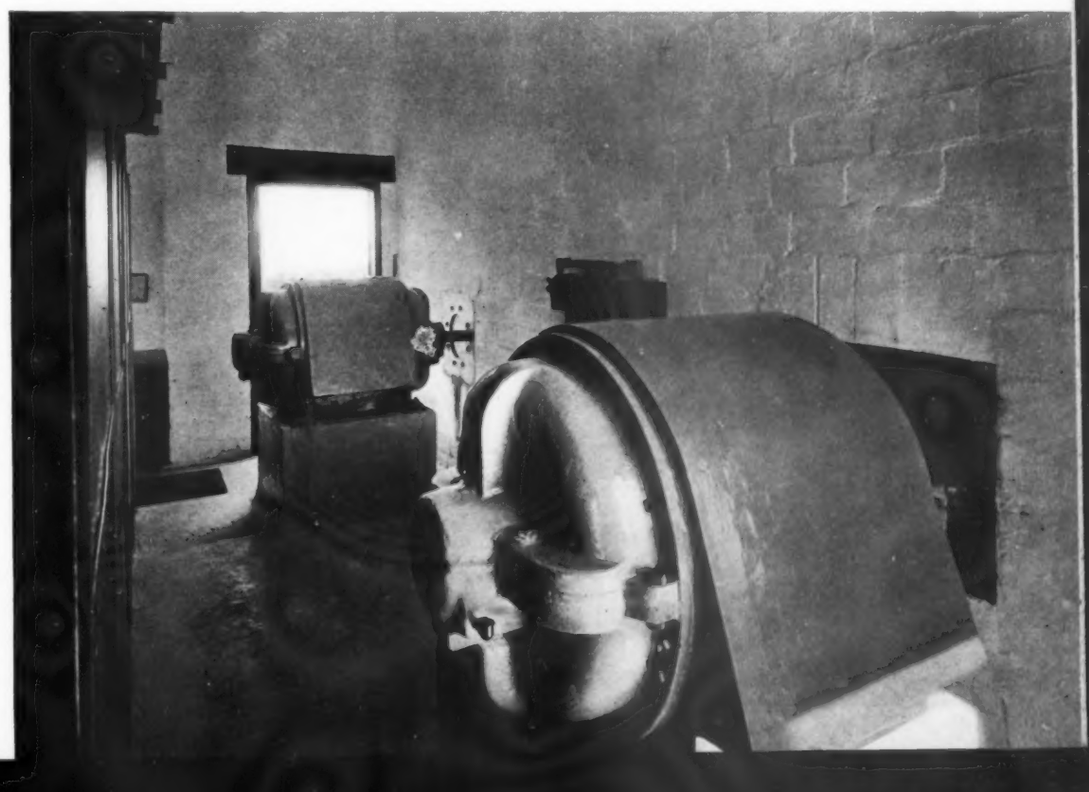
Where pumping requirements vary widely from day to day or season to season as frequently happens on a gasoline line, the brush-shifting type of adjustable-speed A-C motor has the advantage of permitting convenient, accurate speed setting over a wide speed range without the larger losses of efficiency experienced with the slip-ring motor.

The horsepower and speed limitations of this type of motor, as well as its relatively high first cost, limits the possibilities of its extensive use in pipeline service. Nevertheless, there are certain applications where it fits into the economic situation well and undoubtedly it should be given consideration where variable-speed drive is required.

The brush-shifting type of motor, as well as the synchronous and slip-ring motors, require a fire wall to be constructed between the motor and the pump in order to assure the prevention of fire by sparking at the motor brushes igniting an explosive mixture.

Squirrel-cage motors have been installed in the pump room on crude-oil lines, without

Two 350 H.P., 3600 RPM, 2200 volt squirrel-cage induction motors driving 6-inch, 3-stage, 400 lb. 42,000 bbl. centrifugal oil pumps through a fire-wall in a pipeline pumping station in Texas.



a fire wall between the motors and the pumps, in a very large number of cases. So far as we know, there have been no fires in any pump station that could be traced to the motor or control equipment for its origin.

Occasionally a proposed pipeline station location is such that a large expenditure is necessary to serve this station with central station energy. When such a problem arises, the Diesel engine is, of course, immediately considered.

The Diesel engine can be used with speed-increasing gears and centrifugal pumps, but certain definite advantages are obtained by the use of Diesel engines and electric generators with motor-driven centrifugal pumps. Several such stations have been installed and the following advantages have been realized:

1. Low maintenance on the electrical equipment.

2. Flexibility in operation is afforded; that is, with a two-pump installation, either pump can be operated from either engine, either engine can be operated conveniently without load for adjustment, etc.

3. Electric energy is readily available for driving station auxiliaries and lighting operators' cottages without investment in additional generating equipment.

4. If increased pumpage at a station requires the original pumps to be replaced with larger pumps at some later date, the original engines and generators can still be used by adding one more engine-generator set of suitable capacity.

5. When requirements for pumping are such that a station can be eliminated, the engine-generator sets can be readily moved to another station or to a producing property where electric motors may be used.

6. The speed of the pumps can be changed readily, merely by changing the speed of the engines.

7. Complete tests of station operation can be made easily by the use of electrical instruments. This allows the fuel and lubricating oil consumption of the engines to be accurately checked against energy generated and also provides a convenient, accurate means for checking pump efficiencies. Therefore, the cause of excessive fuel and lubricating consumption can be quickly found and corrected with resulting saving in operation cost.

8. By means of a watthour meter on each generator panel, the exact amount of energy put out by each engine can be determined easily for any given period of time. This is of material help in arranging operating schedules.

9. If one engine is installed to drive two pumps, it is not necessary to run both pumps at all times or to uncouple one pump in order to run the other. Either pump can be operated at will with resulting convenience and saving in operating costs.

10. The total cost of the completely installed station compares favorably with the engine-gear type of station.

11. High-speed, efficient pumps can be used without increased first cost or increased maintenance cost.

12. Slow-speed engines can be used without encountering any difficulty in respect to speed-increasing ratio.

13. Any number of engine-generators can be used to furnish energy to two pumps. This means that several relatively small engines in the stock of a pipeline company can be used with generators to drive two large motor-driven centrifugal pumps.

14. Equipment is simple to operate.

15. Motor-driven pump in this type of station may be used later at some other station location with purchased power.

16. Motor-driven pumps in existing stations can be used with engine generators.

Stations using engines and generators with motor-driven centrifugal pumps have been in operation almost constantly for nearly three years. The operation of these stations has been economical and highly satisfactory.

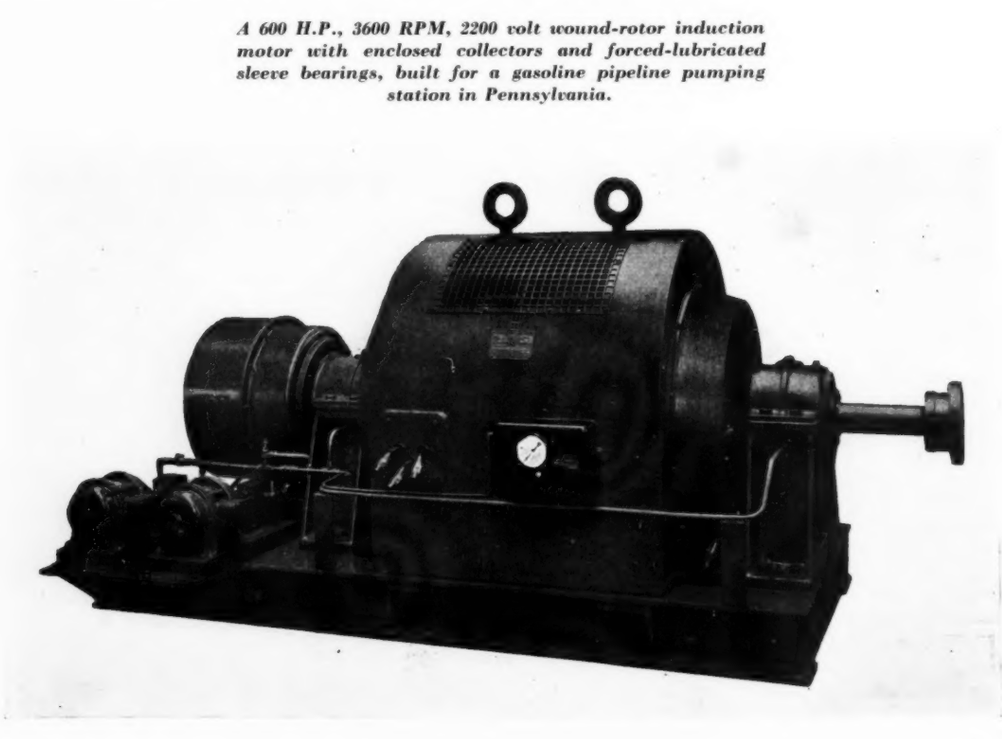
CONCLUSION

Pipeline operators are now thoroughly aware of the advantages afforded by the use of motor-driven centrifugal pumps with purchased power. Power companies and electrical manufacturers, as well as the pump builders, appreciate the problems of pumping oil and gasoline in pipelines, and consequently are able to cooperate with the pipeline operators to a much greater extent in the solution of these problems.

Where purchased power is not available, engine generators still permit the use of motor-driven centrifugal pumps and provide many advantages which have proved out in actual operation over a period of time.

With the foregoing in mind, it seems evident that the pipeline industry should use electrical service and electrical equipment for pumping oil and gasoline to an even greater extent in the future.

A 600 H.P., 3600 RPM, 2200 volt wound-rotor induction motor with enclosed collectors and forced-lubricated sleeve bearings, built for a gasoline pipeline pumping station in Pennsylvania.



IRISH REFINING MONOPOLY

(Continued from page 33)

Thames Haven profits would be serious unless means of replacing them were found. It is estimated that the gross revenue of the company received from business with the major oil groups approximates to the total average profits of London and Thames Haven. It is now reported that other important groups in addition to Shell are definitely terminating their contracts with London and Thames Haven.

Another factor affecting the position of London and Thames Haven is found in the fact that it is now subject to effective competition for the first time in its history. This competition is offered by London and Coastal Oil Wharves, Limited, which has completed a storage and refining plant at Canvey Island, in the Thames estuary, under the managing-directorship of N. A. Anfilogoff, a former Thames Haven chemist and refinery manager.

In the British House of Commons it was intimated recently that the major oil companies were collaborating with the Government in building up the national defence oil storage scheme. This suggests that the volume of storage capacity in Britain will be greatly increased, possibly to the ultimate detriment of undertakings already owning storage installations.

Mr. Burgess referred in his recent speech to "fighting a battle" in the oil trade, and events during recent months certainly seem to be shaping in that direction. Discussing possibilities of the future, Mr. Burgess threw out a strong hint that his reply to the severance of relations by the major oil groups might be an entry by Thames Haven into the distributing business in England.

Parent Petroleum Interests, with which Mr. Burgess is now so closely linked up, has already been credited with designs on the English distributing market, and Mr. Burgess was doubtless envisaging cooperation with Parent Petroleum Interests in any attempt to capture a place in English distribution. If such an attempt is ever made, the Irish imbroglio will have even wider repercussions on the British petroleum market than it has had up to the present time.

READER'S COMMENTS ON SULPHUR AS A CIRCULATING FLUID

To the Editor of World Petroleum:

SIR,—The article in your March issue about the use of sulphur in oil-well drilling was of interest. It seems, however, that you could have placed more stress upon the possibility of successfully shutting off water in cases where considerable difficulty has been encountered with the use of oil-well cement.

In attempting to perform permeability tests a few months ago on some sandstone cores extracted from wells at depth we had difficulty in mounting a six-inch length of the core in a section of four-inch pipe so that fluid would pass from a window on one side to another window on the opposite side without by-passing around the core next to the inner wall of the pipe. Before we learned that oil-well cement and asphalt were proper for mounting such a core, we tried melted sulphur. This set the core firmly in the pipe. On test, however, the core proved to be impermeable, although the sulphur coating had been removed at both windows, and a one-quarter inch slice of the core itself had been scraped off in order to reach uncontaminated sandstone. When a pressure of 250 pounds per square inch was applied at one window, with the other window open to the atmosphere, neither water nor air could be forced through the remaining three-inch section of core. After heating and removing the core we examined it to see what had happened. The sulphur had thoroughly impregnated the sandstone. All pores were entirely filled. Either the fumes of sulphur had permeated the entire core, or molecular pressure on cooling had pressed liquid sulphur through to the center of the core, where it solidified on further cooling.

Cement and asphalt can not penetrate the outer surface of sandstone. It therefore occurs to us that the setting of strings of casing in thin shales overlain and underlain by porous sandstone, or the setting of casing in thicker broken shales, may be facilitated by using melted sulphur in place of cement. The actual penetration of sulphur into the rock surrounding the shoe of the casing will insure a positive bond between the pipe and the body of the surrounding formation.

STANLEY C. HEROLD
Los Angeles, California.

BRITISH TANKERS INADEQUATE

(Continued from page 37)

case in a national emergency, a tramp ship will carry 170 tons and another 170 tons home, i.e., 340 tons of cargo on the round voyage for every 100 tons, but a tanker on the other hand has a smaller deadweight capacity in proportion to its gross tonnage, only 150 deadweight tons for every 100 gross tons, and is a one way ship, so that 100 gross tons of tanker can only carry 150 tons of cargo home and no cargo out. This is only partly compensated for by the fact that tankers have quicker loading and despatch and by the tendency to build tankers of greater speed. At present it is probable that three tons of tanker are no more useful to a country which requires tonnage both for imports and for exports than two tons of tramp. A position nearer equality will, of course, be reached when high speed tankers such as the 20-knot boats constructed by the Japanese become the rule.

To sum up, the rapid and perhaps inevitable displacement of coal by oil has brought new and important problems to British merchant shipping which will take a long time to solve and which may require in the interests of safety not only an increase in total merchant marine but an important change in the proportion of tramp and tanker tonnage in its composition unless the march of progress can be stopped and coal can again come into its own as the chief propellant for the world's ships.

BRITISH IMPORTS FIRST QUARTER

BRITISH oil imports during the first quarter of 1937 show only a small increase against the corresponding period of 1936. The decline in crude imports during the first quarter of this year is due to smaller shipments from Iraq and Venezuela. This decline was, however, partially offset by increased shipments from Netherland West Indies and Peru. Increased shipments from Peru reflect greater activity on the part of Lobitos Oilfields, Ltd. The Netherland West Indies remained the most important source of British motor spirit imports. With British industries operating on heavier schedules than during the first quarter of 1936, the decline in lubricating oil imports suggests that a greater part of the lubricating oil supply is being manufactured in the United Kingdom from imported crude oil. A big increase in the quantity of fuel oil imported is noticeable despite the fact that shipments of this classifaction from Netherland West Indies decreased.

BRITISH OIL IMPORTS BY PRODUCTS
(Barrels)

	March 1937	3 months to March 30 1937	3 months to March 30 1936
Kerosene	383,000	1,548,000	1,568,000
Motor spirit	3,787,000	8,770,000	8,968,000
Lubricating oil	261,000	548,000	828,000
Gas oil	317,000	851,000	826,000
Fuel oil	1,567,000	4,828,000	3,936,000
Other sorts	64,000	168,000	96,000
Total products	6,379,000	16,653,000	16,222,000
Crude	907,000	2,999,000	3,294,000
Total imports	7,286,000	19,652,000	19,516,000

Foreign Oil Legion

RUSSELL W. CARTER, SAMUEL P. DUFFIELD and WILLIAM H. DUNLAP, drillers formerly in California fields, left New York April 16th aboard the ORANJE NASSAU (Royal Netherlands Steamship Company) for Maracaibo where they are due to arrive May 11th. From thence they will proceed to their new home at the El Mene field of British Controlled Oilfields Ltd.

LEONARD WAMMOCK and JOHN E. SEARLES, well-known California drilling superintendents left San Pedro April 20th on board the PRESIDENT VAN BUREN for Miri, Sarawak, where they will be associated with Sarawak Oilfields Ltd., Royal Dutch-Shell affiliate.

ROBERT HARCUS, drilling superintendent for Assam Oil Company Ltd. with headquarters at Digboi, Upper Assam, has been visiting Scotland and is expected to arrive in the United States in May accompanied by Mrs. Harcus, a Long Beach girl.

ALEXANDER ANDERSON, president of the Alexander Anderson Company, sold out his interests to Lane-Wells Company and retired from business April 1st. Born of Scottish parents and educated in Britain and America he has led an interesting life.

Mr. Anderson came to the United States to study production and drilling by way of mining in Shanghai. He settled in Fullerton, California, where he obtained a position as instructor of geology in the Fullerton Junior College from 1921–4, and during this time worked out and patented several of his oilwell survey services.

Recognition came slowly due to its departure from accepted practices, but when he successfully surveyed Olinda No. 96, C.C.M.O.'s deep well in 1926 the industry woke up to see the possibilities of the service he had established.

Mr. Anderson will travel again and leaves shortly for Africa. His retirement may be temporary as his oilfield experience in past years may have gotten into his blood.

CHARLES C. HART, who was United States Minister to Teheran in 1930–34, and who recently negotiated an oil and pipeline concession in Iran for the Amiranian Oil Company, has been on a visit to Baghdad. Mr. Hart also negotiated an oil concession for the same oil group over five provinces in Afghanistan. The Iranian concession is situated in Khorassan (Mohammerah) and Eastern Mazanderan, while the pipeline route from both countries to Chaban, on the Persian Gulf, is over 1,000 miles long.

PAT HENRY, geologist and resident engineer for Richmond Petroleum Company of Venezuela, subsidiary of Standard Oil Company of California, has just spent a month in San Francisco. Standard of California controls over 80,000 acres of land in Venezuela, through Richmond, which has been inactive for some time past but there is every indication that they are going to open this up soon.

MARTIN HESS, former drilling superintendent for British Controlled Oilfields Ltd., recently sailed for Venezuela to rejoin the company after working for some time in the Mid-Continent area.

SAM KATZ, who held a contract to do all the drilling for Petroleos de Mexico S.A. (Petromex, recently reorganized government oil company), is said to be contemplating action to maintain his contract. We hear that A. W. SIMMONS, who has been representing him in Mexico, recently returned to California and is now on his ranch at Ukiah.

Executives of the recently reorganized Richfield Oil Corporation. Left to right: Chas. S. Jones, president; H. R. Gallagher, director; Harry F. Sinclair, chairman of the board of directors; and William C. McDuffie, director and chairman of the executive committee.

HELEN LOUISE MELLON, daughter of J. S. MELLON, export manager of Byron Jackson Company, recently left New York on the first stage of an extended European tour, commencing in Italy. Miss Mellon, who has been associated with her father in business for the past few years, has a wide circle of friends in the oil industry and has included in her itinerary attendance at the World Petroleum Congress in Paris, June 14th to 19th.

E. E. PEAKE, district superintendent for Lago Petroleum Corporation at Lagunillas, has returned to his home state of California for a visit, from whence he embarks on a hunting expedition in Canada.

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Helmar Hedstrom

HELMAR HEDSTROM, well-known Swedish geophysicist and representative of Lane-Wells Company in Europe and the East, sailed from New York April 17th on his way to Stockholm after two months spent in California and Texas. Mr. Hedstrom has been studying the latest developments in drilling surveys, directional drilling and servicing of wells, all of which, he says, are subjects of particular interest to drilling and operating companies in the eastern hemisphere.

H. D. HUSKEY, drilling superintendent for Iraq Petroleum Company Ltd. with field headquarters at Kirkuk, is due in California on home leave in July or August.

FRANK GILSTRAP, superintendent of production for Tropical Oil Company at Barranca Bermeja, Colombia, is expected to arrive in California in June on leave of absence.

Arthur Iddings, in charge of International Petroleum Company's field at Talara, Peru, snapped informally with Mrs. Iddings by Miss E. Phyllis Snyder on a recent visit.

ANDRES ROZLOSNICK, chief of the mining and geological department, AMELIO MONTANE, engineer in charge of equipment standardization, and PEDRO REY, chief geophysicist, of the Y.P.F. (Yacimientos Petroliferos Fiscales—Argentine Government Oilfields), who have been making an extended tour of California oilfields and equipment supply houses, left Los Angeles April 9th for New York where they have been making their headquarters for several weeks at the Hotel Commodore.

C. E. NORDBLOOM, assistant drilling superintendent for the Burmah Oil Company Ltd. at Yenangyaung, Upper Burma, is now home on leave of absence and can be reached at 314 Victor Street, Santa Barbara.

B. H. VAN DER LINDEN, executive in charge of drilling operations for N.V. de Bataafsche Petroleum Maats. (Royal Dutch), accompanied by H. BLOEMGARTEN of St. Louis, vice president in charge of production for Shell Petroleum Corporation, left Los Angeles toward the end of March after an extended stay.

S. L. SLAUGHTER, drilling superintendent for International Petroleum Company Ltd. at Talara, Peru, left there April 26th bound for California where he is spending his leave of absence.

LOWELL GREEN, of the petroleum engineering department of Tropical Oil Company at El Centro, Colombia, is arriving in Los Angeles Harbor May 9th aboard the Grace liner SANTA ROSA to spend his leave of absence in California.

E. L. DECKER, of Martin-Decker Corporation, left by Pan-American Airways for a six week trip to South America. Leaving from Grand Central Terminal at Glendale April 13th he spent the night in Mexico City, then Guatemala City and a few days at Panama. Thence he flew along the east coast to Barranquilla, Colombia, and by German plane into the interior to Barranca Bermeja and back to the coast again. By Pan-American Airways he will travel on down the coast to Venezuela visiting the Maracaibo and Caripeto fields, and will spend a few days at Trinidad. On his return he plans flying by way of Miami for the bathing and fishing and Houston to check on Gulf Coast activity. At the completion of "Dec's" trip in July, "FROSTY" MARTIN is starting an east-bound trip around the world which will take him to all of the important oil producing areas except Russia. He expects to be gone about a year and a half.

E. L. Decker with Airman Thayer

U. S. EXPORTS

(Continued from page 47)

had a favorable balance of trade in petroleum and products amounting to $217,789,000 in 1935 and the even greater favorable balance of trade in petroleum in 1936 of $222,710,000. During January of 1937 the exports of crude oil ran below the monthly average for 1936, the former figure having been 3,596,000 bbl. valued at $4,775,000 while the average for 1936 was 4,177,000 valued at $5,512,000. Gasoline exports during January this year, however, exceeded the 1936 monthly average, being valued at $5,882,000 against an average of $5,173,000. Distillate and residual fuel oil and gas oil exports for January were valued at $3,936,000, far above the 1936 monthly average of $2,743,000. Other petroleum products exported during January 1937 were of approximately the same value as the monthly average for the year 1936.

In February, this year, the total value of all petroleum exports was $24,418,000, a gain of $1,400,000 over the month preceding and of $7,536,000 or 47 percent over February 1936. The largest increase was in exports of lubricating oils which amounted to 910,834 bbl. in February 1937 against 654,720 in January and 417,769 in February of last year.

With this excellent start, with the value of all petroleum products higher than in previous years and with the consumption of most classifications increasing more rapidly abroad than in the United States, the year 1937 looks as if it might well be a record year for the exportation of petroleum and products.

IRAQ OIL IMPORTS

REFINED oil imported from the Anglo-Iranian Oil Company's oilfields at Abadan into Iraq, by way of Basrah, has increased by 50 percent monthly, the consignments now totalling 45,000 tons. Crude oil imports from Abadan have grown owing to the much wider use in the country of irrigation plants and also for fuelling the Kut barges now under construction for the Iraq Government by a British firm of engineers.

BAHREIN DEVELOPMENTS

THE OUTPUT of the new refinery at Bahrein, on the Persian Gulf, will be 12,500 bbl. of petrol daily by August. This will be additional to the present monthly export of about 300,000 bbl. of crude oil.

Arrangements have been concluded for the sale of petrol throughout India by the California and Texas Oil Company with the Texas Company of India, Ltd.

The California and Texas Oil Company estimates that it will spend £750,000 for the first year or two in placing Bahrein products on the Indian market, said Howard M. Herron, President of the company, on arriving in Bombay from Bahrein.

Great Britain is reported to have concluded arrangements with the Standard Oil Company operating the Bahrein oilfields for supply of petrol for British steamers and vessels, presumably the British Navy, and for British aircraft requirements, which is taken to indicate the Royal Air Force. These supplies were formerly taken from Iran.

JAPAN'S 1936 IMPORTS

JAPAN'S imports of crude and heavy oils and petroleum products increased sharply in 1936. Crude and heavy oils rose 434,000 kilolitres or 11 percent to 3,912,377 kilolitres, while gasoline and kerosene advanced 33,000 kilolitres or six percent to 729,854 kilolitres, as compared to the 1935 imports. The United States dominated, as usual, in the 1936 shipments of crude and heavy oils to Japan. Netherlands India topped other countries in the supply of gasoline and kerosene.

Japan's Imports of Crude and Heavy Oils
(In kilolitres)

Origins	1936	1935
U. S. A.	2,878,746	2,610,706
Netherlands India	508,822	404,562
British Borneo	318,679	186,078
Manchukuo	72,520	53,490
Others	133,610	222,978
Total Imports	3,912,377	3,444,315

Japan's Imports of Gasoline and Kerosene
(In kilolitres)

Origins	1936	1935
Netherlands India	482,133	460,651
U. S. A.	164,740	110,284
Asiatic Russia	25,849	17,530
Germany	506	818
British Borneo	199	5,397
Others	16,427	101,316
Total Imports	729,854	695,996

GULF EXPORT PRICES FOR MAJOR OIL PRODUCTS

Products		Cents per Gallon			
		Mar. 17	Mar. 24	Mar. 31	Apr. 7
Gasoline:	U. S. Motor	5¾	5¾	5¾	5¾
	64/66-375 E.P.	6⅛	6⅛	6⅛	6⅛
	59 Octane & below	5¾	5¾	5¾	5¾
	65 Octane & above	6⅛	6⅛	6⅛	6⅛
Aviation Gasoline: (Tank-car F.O.B. Ref.)	73 Octane & above	10	10	10	10
Kerosene:	44 w.w.	5⅜	5¼	5⅛	5⅛
	41-43 w.w.	5	5	4⅞	4⅞
	41-43 p.w.	5	5	4¾	4¾
Gas Oil:	26-30 translucent	3¾	3¾	3¾	3⅞
	30 plus translucent	3⅞	3⅞	3⅞	3¾
Fuel Oil:	Grade C Bunker (per bbl.)	$1.00	$1.00	$1.00	$1.00
	Cargo lots (per bbl.)	.95	.95	.95	.95
	Diesel oil (per bbl.)	1.65	1.65	1.65	1.65
Lubricating Oil: (New York Export Market)	Bright Stock No. 8	31½	32	32	32
	Bright Stock No. 6½	31	31	31½	31½
	600 Warren E.	26	26	26	26
	600 Unfiltered s.r.	24	24	24	24
	650 Unfiltered s.r.	25	25½	25½	25½
	600 Flash s.r.	26	26½	26½	26½
	630 Flash s.r.	27½	30½	31	31
	Neutral 200 No. 3	31	31½	32	32
	Neutral 150 No. 3½	27	27½	28	28
So. Texas:	Red oil 500 No. 5-6	7½	7½	7½	7½
	750	8¾	8¾	8¾	8¾
	1200	9½	9½	9½	9½
	Pale oil 500	7⅝	7⅝	7⅝	7⅝
	750	8¾	8¾	8¾	8¾
	1200	9½	9½	9½	9½
Crude Oil:	East Texas crude delivered at Gulf port for export (per bbl.)	$1.52	$1.52	$1.52	$1.52
	Venezuela crude (per bbl.)	1.05	1.05	1.05	1.05
	Trinidad crude (per bbl.)	.90	.90	.90	.90
	Panuco crude (per bbl.)	1.25	1.25	1.25	1.25

Freight Rates

	Jan. 20		Feb. 10		Mar. 17		Apr. 7	
	Dirty	Clean	Dirty	Clean	Dirty	Clean	Dirty	Clean
(Shillings per ton)								
Calif.—U. K. or Continent	20/-	21/6	20/-	28/-	No booking		No booking	
Gulf—U. K. or Continent	14/6	19/-	21/-	25/-	33/-	31/-	36/-	36/-
Aruba—U. K. or Continent	12/-	14/-	19/6	23/6	29/-	25/-	29/6	31/6
(Cents per barrel)								
Calif.—North Atlantic	90 nom.		90 nom.		90 nom.		90 nom.	
Gulf—North Atlantic	44	39	45	40	45	38	48	39
Venezuela—North Atlantic	18 nom.		35	—	41	—	47	—
Tampico—North Atlantic	20 nom.		40	—	50	—	50	—

WORLD OIL PRODUCTION—Official Figures

All figures furnished direct to WORLD PETROLEUM by governments, except where otherwise specified—Table revised monthly

(Figures in U. S. Barrels—Conversion ratio 7 bbl.=1 ton)

Country	April 1936	May 1936	June 1936	July 1936	August 1936	September 1936	October 1936	November 1936	December 1936	January 1937	February 1937	Provisional Figures March 1937
United States	90,479,000	93,739,000	90,185,000	92,078,000	95,090,000	90,972,000	95,795,000	91,018,000	97,652,000	98,567,000	93,173,000	97,195,000
Russia	15,589,000	16,454,200	15,955,100	16,231,600	15,737,500	14,936,600	16,118,900	16,700,000 [1]	16,400,000 [1]	16,100,000 [1]	14,600,000 [1]	15,800,000
Venezuela	13,442,870	13,732,933	12,486,600	14,566,510	14,632,737	14,626,073	13,888,287	14,307,650	8,452,626	9,888,298	13,583,024	15,584,002
Roumania	5,226,000	5,568,000	5,563,000	5,606,000	5,585,000	5,254,000	5,224,000	4,982,000	5,050,000	4,768,000	4,217,000	4,721,000
Iran [2]	4,312,000	5,376,000	5,061,000	4,872,000	5,117,000	4,487,000	4,704,000	4,620,000	4,963,000	5,250,000	4,417,000	5,577,000
Netherland India	3,532,375	3,721,613	3,549,417	3,725,491	3,715,887	3,731,973	4,059,426	4,139,954	4,190,578	4,009,355	3,768,975	4,148,732
Mexico	2,997,883	3,235,255	3,167,300	3,179,614	3,773,503	3,768,855	3,235,224	3,204,007	4,259,733	4,233,635	3,923,000 [1]	4,308,000
Iraq	2,048,053	2,467,136	2,473,660	2,440,669	2,479,428	1,881,782	2,097,564	2,214,954	2,207,954	2,476,698	2,240,119	2,542,883
Colombia [3]	1,427,193	1,598,544	1,529,901	1,585,345	1,553,606	1,575,273	1,600,288	1,537,683	1,641,636	1,668,490	1,617,441	1,675,000
Peru [4]	1,403,626	1,500,485	1,452,306	1,524,303	1,527,072	1,478,482	1,507,433	1,445,605	1,492,023	1,448,545	1,321,989	1,464,979
Argentina	1,260,277	1,231,354	1,140,080	1,286,536	1,293,283	1,323,730	1,306,784	1,356,396	1,473,000 [1]	1,317,000 [1]	1,190,000 [1]	1,317,000
Trinidad	1,026,423	1,066,728	1,078,186	1,121,583	1,108,969	1,126,420	1,179,611	1,154,093	1,231,365	1,263,456	1,157,408	1,287,097
British India	790,376	827,762	778,947	817,364	815,415	791,217	730,860	778,617	809,218	788,299 [1]	729,988 [1]	745,000
Bahrein	293,696	340,104	295,567	564,607	780,265	422,799	209,086	419,643	619,910	730,064	549,260	672,000
Poland	323,400	331,100	287,000	294,000	301,000	294,000	301,000	294,000	301,000	295,400	273,000	298,000
Brunei	270,900	225,890	206,780	266,700	275,310	257,040	294,070	294,560	322,210	354,480	327,600	125,650
Germany	246,519	244,552	256,613	275,699	257,859	255,556	277,158	265,650	279,545	265,531	233,366	245,007
Japan	194,167	203,071	198,387	206,284	221,139	207,260	200,528	202,385	212,326	219,410	194,037	214,000
Ecuador	159,666	163,855	156,703	163,714	160,914	158,857	168,892	163,870	175,918	180,058	160,675	180,727
Sarawak	130,900	134,610	128,660	130,200	129,150	122,010	127,330	122,920	128,240	125,440	114,380	139,650
Canada [5]	107,748	114,297	114,050	139,940	139,789	135,623	137,004	129,152	139,701	141,078	153,906	155,876
Egypt	101,038	107,989	106,694	106,260	102,620	98,812	102,109	97,755	98,672	99,589	86,842	93,499
France [1]	43,530	44,981	43,530	44,981	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000
Others [1]	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
Total	145,481,640	152,504,459	146,289,481	151,299,400	154,917,446	148,025,362	153,384,554	149,568,894	152,220,655	154,309,826	148,152,010	158,542,602

[1] Estimate. [2] Anglo-Iranian Oil Co. figures revised; fuel oil returned to the ground has been deducted. [3] International Petroleum Company's figures. [4] International Petroleum Company and Lobitos Oilfields Ltd. figures. [5] Includes natural gasoline production.

Russian Sakhalin included with Russia. Japanese Sakhalin included with Japan.

Official Crude Oil Production Figures for 1932 to 1937

	Daily Average to Mar. 31 1937	Daily Average 1936	Total to Mar. 31 1937	Total 1936	Total 1935	Total 1934	Total 1933	Total 1932
United States	3,201,389	3,001,410	288,935,000	1,098,516,000	996,596,000	908,065,000	905,656,000	785,139,000
Russia	516,600	524,348	46,500,000	191,911,200	176,688,100	168,648,700	149,901,900	149,719,000
Venezuela	433,949	436,900	39,055,324	159,905,526	154,021,599	140,784,805	120,882,802	119,596,512
Roumania	105,229	173,527	13,706,000	63,511,000	61,150,000	62,006,000	50,971,200	50,491,205
Iran	169,378	177,424	15,244,000	59,386,833	52,413,879	52,663,782	48,581,280	45,122,455
Netherland India	132,523	122,030	11,927,062	44,662,857	42,569,625	42,289,408	38,512,663	39,584,027
Mexico	138,496	112,095	12,464,635	41,026,724	40,234,902	38,167,022	33,904,882	32,802,285
Iraq	80,663	74,484	7,259,700	27,261,087	24,850,924	7,935,657	1,200,000	1,200,000
Colombia	55,121	51,246	4,960,931	18,756,110	17,617,645	17,340,724	13,157,127	16,834,956
Peru	47,061	47,415	4,235,513	17,353,778	16,835,206	15,936,937	13,923,281	9,899,266
Argentina	42,409	42,492	3,824,000	15,551,998	14,317,500	14,045,652	13,759,565	13,166,900
Trinidad	41,199	36,167	3,707,961	13,237,075	11,669,792	10,894,363	9,560,039	10,023,780
British India	25,136	26,071	2,262,287	9,541,966	9,227,496	8,997,399	8,721,655	8,600,312
Poland	9,626	9,773	866,400	3,577,000	3,612,000	3,697,617	3,858,085	3,905,230
Bahrein	23,100	12,725	2,079,000	4,644,635	1,264,807	285,072	31,377	902
Brunei	8,975	8,639	807,730	3,162,040	3,162,614	2,673,041	1,963,661	1,233,925
Germany	8,265	8,504	743,904	3,112,480	3,054,023	2,266,964	1,712,823	1,824,019
Japan	6,971	6,515	627,447	2,384,378	1,848,656	1,484,962	1,337,761	1,575,333
Ecuador	5,794	5,252	521,460	1,922,215	1,725,354	1,655,062	1,622,624	1,573,857
Sarawak	4,216	4,253	379,470	1,556,660	1,811,297	1,948,044	2,289,472	2,274,043
Canada	5,009	4,110	450,860	1,504,287	1,447,204	1,422,869	1,162,541	1,044,412
Egypt	3,110	3,341	279,930	1,222,865	1,215,606	1,479,037	1,591,495	1,742,370
France	1,500	1,459	135,000	534,063	529,664	552,000	552,000	552,000
Others	2,050	2,459	225,000	900,000	900,000	861,000	432,000	432,000
	5,066,328	4,902,639	461,198,614	1,785,142,777	1,640,763,893	1,506,101,117	1,425,286,233	1,298,357,789

WORLD PETROLEUM ABSTRACTS

Summaries of the Most Important Articles as Published in the Oil Press of the World Dealing With Technical and Economic Aspects of the Industry. **Edited by Dr. O. W. Willcox**

PETROLEUM GEOLOGY

INSOLUBLE RESIDUES OF DUNDEE AND DETROIT FORMATIONS OF CENTRAL MICHIGAN.—Dean C. Wellman, in BULL. AMER. ASSOC. PETROLEUM GEOLOGISTS, vol. 21 (1937), No. 3, pp. 317–332.

The correlation of the formations of Michigan is a difficult problem for the stratigrapher. It has been possible by means of fossils only locally in the restricted areas where the formations crop out, and these are far from the central Michigan area where definition is most desired for oil-field development. As there is a thick cover of drift in this part of Michigan, subsurface work is necessary, and lithologic features as shown by well cuttings have been generally used in correlation. These have been sufficient in many places where the formations exhibit distinctive lithologic character in wide areas, but where adjacent formations such as the Dundee and Detroit River are similar lithologically the method has not always met with success. Furthermore, there is no definite method for the location of horizons within the Dundee, which is highly desirable as this formation is the chief source of petroleum in this region. For locating horizons and tentatively defining these two formations the author developed a method of identification based on a study of the insoluble residues left when samples of well cuttings are dissolved in 50 percent hydrochloric acid. The mineral particles found by this method are sufficiently different to admit of fairly clear differentiation.

PHYSICAL CHARACTERISTICS OF BARTLESVILLE AND BURBANK SANDS IN OKLAHOMA AND KANSAS.—Constance Leatherock, in BULL. AMER. ASSOC. PETROL. GEOLOGISTS, vol. 21 (1937), No. 2, pp. 246–258.

The Bartlesville and Burbank sands, which occur in the Cherokee shale of the Pennsylvanian series, are composed of quartz grains loosely cemented with a mixture of magnesium, iron, and calcium carbonate, and locally by silica, dolomite, or calcite. The sand commonly contains new quartz growth. Aside from quartz the sand contains ½–2 percent, commonly one percent mica, traces of feldspars, zircon, chlorite, glauconite, hornblende, rutile, magnetite, pyrite, and epidote, 10–20 percent detrital rock fragments (chert, shale and schist), and a trace to 10 percent of carbonaceous material. Locally, as much as 50 percent of the sand grains are composed of altered magnetite. Marine fossils were found in the sands and also in thin limestone and shale beds within and immediately above and below the sands.

The sands in most localities are predominantly fine-grained, but locally have a large content of medium and coarse grains and a trace of very coarse grains. The sand in most localities contains 10 percent silt and clay, but locally the fraction ranges from 5 to 40 per cent. Most of the medium-grained sand and essentially all the finer grains are angular to subangular; locally, one-third of the medium grains and, in all localities where present, most of the coarse and very coarse grains are subrounded to rounded.

The Bartlesville and Burbank sands are so similar in composition and physical characteristics that they can not be differentiated with certainty although certain differences can be distinguished in sands from two or more specific localities.

SANDSTONE POROSITIES IN THE PALEOZOIC REGION OF ARKANSAS.—George C. Branner, in BULL. AMER. ASSOC. PETROL. GEOLOGISTS, vol. 21 (1937), No. 1, pp. 67–79; 6 figs.

Porosities were determined of 98 samples of unweathered sandstones collected in the Ouachita Mountains, the Arkansas Valley, and the Ozark Plateaus of Arkansas. The average porosity in the intensely folded beds of the Ouachita Mountains was found to be 5.7 percent, in the beds of the less folded Arkansas Valley, 7.8 percent, and in the comparatively unfolded beds of the Ozark Plateaus, 10.9 percent. The average degree of inclination of the folded beds in the Ouachita Mountains from incomplete figures, is estimated to be 54.1 deg.; in the Arkansas Valley, 17.0 deg.; and in the Ozark Plateaus, 5.1 deg., thus indicating the relationship between the average regional porosities of the sandstones and the average deformation of the folded beds. It appears probable that, if sufficient data were accumulated, a useful relationship could be established between the average regional porosities of the sandstones and the average regional carbon ratios of the coal in western Arkansas.

GEOLOGY OF THE COAST OF ALAGÔAS, BRAZIL.—Victor Oppenheim, in BULL. AMER. ASSOC. PETROLEUM GEOLOGISTS, vol. 21 (1937), No. 3, pp. 299–310.

The sedimentary belt along the coast of Alagôas is the only area in the state which can be considered as offering some interest from the point of view of petroleum geology. It is limited on the west by the extensive area of basement granites and gneiss which form the rest of the state.

Since 1920, 10 wells have been drilled in the Riacho Doce area on the coast of Alagôas. A study of the logs of these wells permits a modification of the previous opinions of Branner and E. Oliveira which were based only on surface observations.

The formations of the sedimentary belt are Tertiary in age. The upper strata, called the Barreiras formation, form extensive red bluffs along the coast; they are poorly stratified and non-fossiliferous. The lower strata, consisting of the gray and dark shales of the Alagôas series, have been paleontologically classified as Eocene. These shales are partly bituminous and are the only known rocks in the state here considered as possibly oil-bearing. Structurally, the shales of the Alagôas series are disturbed, tilted and broken.

The writer, after studying the outcrops and the logs of wells in the Riacho Doce area, admits the possibility of existence of oil in the Alagôas series, but considers the general conditions as somewhat unfavorable for the development of important production. He concludes that a deep test well is desirable, mainly for study purposes, in the most favorable locality and recommends a geophysical survey of the area. The latter is now being made.

OIL POSSIBILITIES IN ITALIAN EAST AFRICA.—A. Belluigi, in BULL. AMER. ASSOC. PETROLEUM GEOLOGISTS, vol. 21 (1937), No. 3, pp. 293–298.

Although surface showings of petroleum in Abyssinia are a matter of record, the structural conditions ordinarily considered favorable and necessary for the accumulation of commercial deposits are absent. The sedimentary rocks seem to lack domes and anticlines, but folds and reservoir traps may be found where thrusting and compression have affected the younger strata in coastal zones or in depressions of the old and solid massif of Abyssomaliland. Oil reservoirs may be found along geosynclinal boundary faults.

GEOPHYSICS

NEW METHOD OF SEISMIC SURVEY.—Lester C. Uren, in OIL & GAS JOUR., vol. 35 (1937), No. 43, pp. 52–54.

During the past few years the Rieber Laboratory at Los Angeles has developed and placed in the field a radically new geophysical system which they have termed the Sonograph.

The Rieber Sonograph differs from its predecessor, the reflection seismograph, not only in the character and appearance of the original records made in the field, but also in the method of analyzing and interpreting these records. Impulses are generated in the earth by explosions, but, instead of being received on geophones of the usual patterns, the Rieber method uses a device termed a "receptor," in which a piezo-electric quartz crystal transforms a selected part of the earth vibrations into electric waves. These waves are then passed through a specially controlled amplifier, and finally recorded on a strip of motion picture film.

The appearance of this Sonograph film differs radically from the usual seismograph record. Instead of earth motion in the familiar form of wavy lines, the film preserves a selected portion of these impulses as variable density wave trains in a form comparable with the "sound tracks" on a motion picture sound film. A field truck carries 10 receptors, which are placed in shallow holes at the surface, and arranged in a special pattern with respect to the shot holes. Insulated cables carried by the truck connect these receptors to the amplifying and recording equipment in the oper-

ating compartment. Vibrations sent in by each receptor are recorded as a separate sound track, 10 such tracks being placed on a strip of motion picture film, together with an additional track for a tuning fork record to indicate time intervals, and another such track on which the instant of the explosion is recorded.

These film records when taken are developed in the truck and inspected by the operator. They are then transported to the office, where they are put through an analyzer that records only waves coming from predetermined directions. The final result is that interfering waves are separated into their component parts so that each can be evaluated separately. It is thus possible to obtain detailed information near faults and other structures that baffle the earlier methods. The new system appears to have far-reaching possibilities.

DRILLING

SALT WATER AS DRILLING FLUID.—T. P. Sanders, in OIL & GAS JOUR., vol. 35 (1937), No. 44, pp. 50–54.

Recent wells drilled in New Mexico and West Texas fields have often used salt water as a drilling fluid mainly for two reasons; it has sufficient weight to prevent blowouts when most gas horizons or "air pockets" are encountered, and it has the advantage that it will bubble through to the surface instead of remaining in the mud to lower its specific gravity to a point where a blowout becomes possible. Another point is that the substitution of salt water brings about a considerable saving in the purchase of mud; as little as four tons of mud per well have been used. The use of brine as drilling fluid is naturally indicated when drilling through salt in order to prevent undue enlargement of the hole from the solvent action of ordinary fresh water.

CONTROLLED VERTICAL DRILLING IN CALIFORNIA.—T. P. Sanders, in OIL & GAS JOUR., vol. 35 (1937), No. 41, pp. 59; 62.

Difficulty in pumping crooked wells has been the chief argument in favor of drilling straight holes, but it now is noted that there is a further advantage in that straight wells can be drilled more rapidly than was formerly thought possible to drill any well; fishing jobs are reduced or avoided and there is less wear on drilling equipment. Another advantage of straight drilling is that corrections can easily be made as to positions of geological horizons, which is important in the case of steeply dipping formations. In all localities the drill tends to descend vertically unless forced aside by hard formations that dip steeply, but sometimes an off-center borehold through the drill collar has been responsible; this is a detail which can be remedied.

The most recent development in straight-hole drilling is the use of sleeves on drill-collars; these sleeves are made with several tons of lead rings around the collar inside of a steel casing. By thus concentrating weight on the drill-collar immediately above the bit, the compressive force on the drill-pipe is removed or reduced to a stress that will not cause crooking. This has been known for some time, but has not been put in practice for lack of a method of fishing out the heavy lead sleeve in case of a twist-off; such a method has now been devised.

When the straightness of the hole is controlled by frequent directional tests and the other necessary precautions are taken, the drilling time may be reduced as much as 40 percent. The only undesirable result of keeping holes straight, noted by one company, is the number of strings of 8⅝" casing which parted after they were set and drilling continued below their casing seats. This is ascribed to vibrations set up by the drill-pipe, which are less noticeable in a crooked hole because the crooks "dampen" the vibrations.

The method by which this trouble was corrected is worthy of note. It was noticed that the V-threads in the casing gave an ideal place for fracture to start. Steel somewhat resembles paper, cloth, or as a more extreme example, cellophane, in that it fractures more easily if given a place for the fracture to start. Apparently the sharp V-threads were providing a start. Casing with round threads was obtained with the same number of threads to the inch. It has been reported by this company that their straight-hole troubles have thus been eliminated.

THE DEEPEST PRODUCING WELL.—T. P. Sanders, in OIL & GAS JOUR., vol. 35 (1937), No. 38, pp. 33–34.

The No. 12 McGonigle well of the Tide Water Associated Oil Co. in the Ventura field, Calif., completed January 17, 1937, is now the deepest producing well in the world. This well has been drilled to 10,569 ft., which is just nine ft. over two miles. Initial production was 533 bbl. of 30.3 gravity oil with 430,000 ft. of gas through a 55/64-inch flow bean.

From an engineering standpoint the most important consideration concerning this recent completion is believed to be that the great depth caused no unusual difficulties. Trouble was avoided mainly because of the great care which was put forth to keep the hole straight. The greatest deviation from the vertical was about three deg. recorded at 7,000 ft. The hole was straightened by reducing the weight on the bit at this depth. An average of 35 ft. of hole per day was made after a depth of 10,000 ft. had been reached. A straight hole was further indicated when a 607-ft. liner was landed at a depth of 10,556 ft. with no difficulty. Since the location is on the flank of a very sharp anticline, characteristic of California oil field structures, the strata penetrated dips steeply. A straight rotary hole drilled through two miles of such strata is an achievement which might have been considered impossible a short time ago. The Tide Water Associated Oil Co. operates its own drilling rigs, and the belief is held in this organization that straight drilling was necessary to reach the great depth without difficulty.

SELECTIVE WELL-COMPLETION IN EAST TEXAS.—Mitchell Tucker, in OIL & GAS JOUR., vol. 35, No. 44, pp. 49–50.

Selective well-completing is now being practiced on an enlarging scale in the Talco, East Texas and Rodessa fields with marked success. Although conditions in these fields vary widely, justification is found in each for this rather recently developed manner of completing wells in proven fields.

The selective method of completing wells differs from the usual practice of setting casing above the oil sand before drilling in. In the more recent method, the entire zone or zones of saturation are cored, drilled and carefully logged, and often the hole is carried to the base of the section, after which casing is set on or near bottom and cemented. The pipe is then gun-perforated opposite the desired points for selective completing to accomplish the desired results.

In the former method of setting pipe above the sand the operator never knew just what he had in the full sand body until probably the exposed portion was depleted or drowned out, and it became necessary to cement off, drill deeper or do exploratory work of one type or another. Whereas, here he sees the entire picture during original drilling of the hole, then selects the most advantageous point from which to produce first. Also, a very accurate well record is available for reconditioning in later field life if needed.

These facts have caused several major operators in the East Texas field to pioneer the selective manner of well-completing by drilling several experimental wells, completely through the Woodbine, and then make Schlumberger hole surveys to afford definite information regarding position of shale streaks, impervious sections of red beds, point or points of oil-water contact, etc. After having this information, productive levels of nearby wells can be studied and together with data obtained from electrical survey, the casing which is cemented on bottom can be perforated opposite the points where it is desired to first take production.

MOLTEN SULPHUR—AN EXPERIMENTAL CIRCULATING FLUID.—Anon. in WORLD PETROLEUM, vol. 8 (1937), No. 3, pp. 46 47.

A 750-ft. well was drilled at Boling Dome (Texas) with rotary tools, using molten sulphur as the circulating fluid. A string of 8-inch casing was set, using the "frozen" sulphur as cement, and the casing was subsequently recovered by reheating the cement. The only special equipment used was a steam coil in the "mud" pit and a section of casing rigged to circulate steam to preheat the drill pipe before running in.

This accomplishment appears to open new possibilities of drilling under certain circumstances, such as for overcoming the difficulties presented by heaving shales and unconsolidated formations; such materials could be consolidated by frozen sulphur and given the required wall strength, effectually shutting off infiltration and doing away with cement jobs. The proposition is still in the experimental stage, and there are certain hazards inherent in this use of sulphur, but it does not appear that these hazards are incapable of being obviated; preliminary cost calculations seem to indicate economic feasibility.

PETROLEUM REFINING

CORROSION OF CONDENSER TUBING IN A GULF COAST OIL REFINERY.—H. M. Wilten, in MINING AND METALLURGY, vol. 18 (1936), No. 363, pp. 143–147.

This article presents a view of a problem encountered in the deterioration of equipment used for condensation of vapors and cooling of liquids in a petroleum refinery. In this case corrosion was due primarily to corrosion on the water side of the tubes; corrosion on the oil side is now not much of a problem in a well-managed refinery, as there is a well-recognized technique for neutralizing a corrosive oil. The water used in this Gulf Coast refinery is low in carbonates (which would form a protective coating) and high in chlorides (which accelerate corrosion).

Steel tubes in oil-to-water service in a cracking unit lasted an average of six months, whereas admiralty metal tubing lasted an average of 15 months. In the same unit where the naphtha stream at 200–300 deg. was cooled by water at 100 deg. the steel tubing gave three to eight months service against 12 to 18 months for admiralty tubing. The ratio of original cost of a tube bundle of steel to that of admiralty metal is 1: 1.18. The steel tubes in water service usually fail from uniform corrosion on the water side, but a number of failures due to water pitting have been noted.

Tubing containing four to six percent chromium and 0.5 percent molybdenum in a cracking unit failed in two months; in this location admiralty tubes lasted 16 months; in an installation in crude pipe stills the failure occurred in four months, admiralty tubing lasting six months.

Installations of 18 percent chromium, 8 percent nickel steel tubes were made in practically all types of service. Comparing the life of 46 exchangers equipped with 18-8 stainless steel tubes with admiralty tubing in the same service, it was found that the stainless steel tubes had an average life of 16 months, whereas the average life of the admiralty tubing was 22 months. The approximate original cost of 18-8 tubing to admiralty tubing was 4 : 1; it is concluded that the 18-8 tubing cannot economically compete with admiralty tubing in the same service.

The most frequent cause of failure of the 18-8 tubing is pitting on the water side. It is remarkable that these fatal pits are few in number, occurring sparsely along the length of the tube. The next most common cause of failures of these tubes is radial cracking. Besides the above mentioned steel tubes, tests made of carbon steel alloyed 12 to 15 percent with chromium and 18 percent chromium did not give satisfactory service.

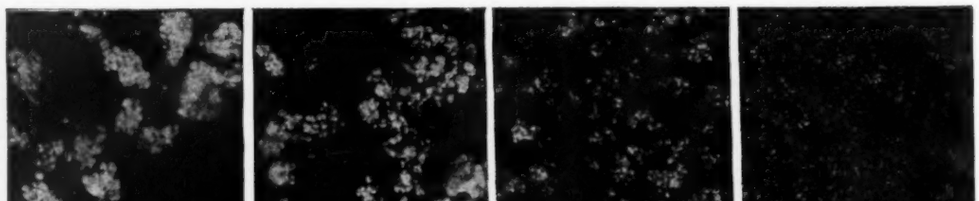
The general result is that, except for a few installations, all steel and alloy steel tubing is losing ground at the Port Arthur works to admiralty and other copper-base alloys; this represents a choice of the lesser of two evils. It is to be hoped that some one will find a passivity treatment that will correct or diminish the corrosion of the stainless steels that are, apparently, in other respects a valuable material for this service.

Wax Precipitation From Propane Solution.—A. P. Anderson and S. K. Talley, in IND. ENG. CHEM., vol. 29 (1937), No. 4, pp. 432–439.

The precipitation of paraffin wax from propane solution was studied from the point of view of commercial continuous filtration. Such a study is opportune because of the smaller filtering surface of continuous filters, such as the Oliver United type of rotary filter, and hence because greater care must be taken in precipitating the wax than when working with batch filters, to ensure rapid filtration and clean discharge of the wet cake. The matter of wax structure, and how it is influenced by working conditions therefore becomes of prime importance.

For observing wax structure use was made of a polarizing microscope. It was found that a number of different wax structures can be obtained in propane dewaxing, and it was possible to correlate these structures with filter rates. The effect of structure on filter rate is indicated by the accompanying illustration.

The best filtering structure has the appearance of popcorn, wherein the wax is gathered into clusters made up of adhering microscopic grains of wax. The important variables in the precipitation are mixing temperature, propane-stock ratio, chilling conditions and crystallizing agents such as asphaltic compounds. As to temperature, it is important to warm the mix considerably above the cloud point before starting to chill. Within wide limits the rate of chilling is not important so long as flash chilling is avoided. A certain amount of agitation, but not violent churning, is helpful; too long circulation of a prepared batch is undesirable. A propane stock ratio of 1.6 to 1 is about the lower limit for good wax structure. The formation of the clusters is greatly facilitated by a small amount of asphaltic resins, such as is left in the residuum by the normal deasphaltizing process.



25 to 15 *15 to 10* *10 to 5* *5 to 0*

Effect of wax structure on filter rate (x 120). *Filter rates in gallons per square foot per hour.*

Intermediate Steels for Refinery Service.—H. D. Newell, in REFINER, vol. 16 (1937), No. 3, pp. 108–112.

The handling of large volumes of sweet or mildly corrosive oil following the discovery of the East Texas field, suggested that there was a place in the refinery for a low alloyed steel of nominal cost with corrosion resistance substantially better than plain steel, with high-temperature strength equal to or better than the five percent chromium-molybdenum type. To meet this need the Babcock & Wilcox Tube Co. developed the Croloy products of the following compositions:

	Croloy 2*	Croloy 3-M*
Carbon	0.15 Max.	0.15 Max.
Manganese	0.30—0.60	0.30—0.60
Sulphur	0.030 Max.	0.030 Max.
Phosphorus	0.030 Max.	0.030 Max.
Silicon	0.50 Max.	0.50 Max.
Chromium	1.75—2.25	2.75—3.25
Molybdenum	0.40—0.60	0.80—1.00

* These steels now appear as Grades 4 and 5 in Manufacturers' Standard Specifications No. 202-36 "Seamless Intermediate Alloy Steel Still Tubes for Refinery Service."

Croloy 2 has found wide application over the past two years as tubes in cracking furnaces and vapor lines and to some extent in heat-exchanger equipment. Croloy 3-M has found a more limited application where its higher strength properties over Croloy 2 could be used advantageously. Croloy 2 still tubes have been used in the construction of several new units by major refining companies, in combination and ordinary cracking furnaces and in reforming units. The alloy has also replaced carbon steel tubes in radiant banks and in other locations in cracking furnaces where corrosion has been encountered or where bulging has been troublesome in carbon steel tubes due to pressure and temperature conditions.

The characteristics of these alloys of enhanced resistance to oil corrosion and scaling over carbon steel, with elevated temperature strength properties exceeding 5 percent chromium, 0.50 percent molybdenum steel and lastly their nominal cost, place these materials in an important position for refinery application. The increasing use of the so-called intermediate steels show them to have a useful place. The development, specialization and intergradation of refining processes suggests that steels of the type described herein can be used to advantage by refinery engineers and operators for improving yields or quality of product and for lowering maintenance costs on equipment.

Nickel-Bearing Alloys for Refinery Service.—B. B. Morton, in REFINER, vol. 16 (1937), No. 3, pp. 101–104.

The 2.25–2.75 percent nickel-bearing steels are very suitable for low-temperature work in dewaxing of lube oils and modifying the selective action of solvents. The 2.5–3.5 percent nickel steels are finding wide application as valve bodies and parts, pump parts, fittings, and as exchanger shells and heads. Monel is outstanding among wrought materials in its resistance to sulphuric acid in concentrations below 95 percent. "Casum metal" (an austenitic cast iron with 13 to 15 per cent nickel and 5 to 7 percent copper) has been reported as giving a life in excess of nine years in acid sludge service. Various nickel-copper alloys have been developed as a substitute for lead equipment handling hot acid sludge, and in other elevated temperature work with sulphuric acid at concentrations below 70 percent.

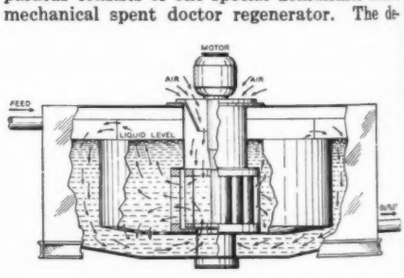
Resistance to corrosion by hydrogen sulphide and hydrochloric acid is obtained by the use of chromium alloys, of which the 18 percent chromium-8 percent nickel is perhaps the best known. Heating-coil tubes of this material tend to rupture when overheated but when intelligently used with a clean feed are satisfactory. Exchanger tubes of the 18-8 metal have given excellent service.

Where water, heat, hydrogen sulphide and hydrochloric acid are present, which is peculiarly the case at the tops of bubble towards, the "Ni-resist" alloy has made a very good showing. K-Monel, a hardened form of monel containing aluminum and which possesses the chemical resistance of monel, is recommended for valve stems.

Since the oil industry has branched out into the organic chemical manufacturing field the chlorination of paraffins and the production of organic acids are being carried out at many refineries. Such work calls for pure nickel or nickel-clad steel for chlorination; chromium-nickel-molybdenum alloys are used with the organic acids. A recent development is a chromium-nickel-molybdenum alloy that can be pierced and is available as seamless tubing. Iconel (80 Ni, 14 Cr, 6 Fe) is finding application for high-temperature syntheses. It also possesses high resistance to oxidation and to many chemicals.

Naphtha Recovery and Doctor Regeneration.—Carl W. Berger, in REFINER, vol. 3 (1937), No. 3, pp. 137–140.

As proof that the conventional plumbite sweetening operation is a wasteful step in refining, the author points to the savings effected by the Bayway combination centrifuging and regenerating process as installed at the McPherson (Kan.) plant of the Globe Oil & Refining Co. The apparatus consists of one special demulsifier and a mechanical spent doctor regenerator. The demulsifier is a continuous bowl centrifugal operating at 1,250 r.p.m. which removes the dispersed naphtha from the caustic and lead sulphide. The regenerator consists of a shallow, flat-bottomed tank in the center of which is a suspended, electrically-driven rotor surrounded by a cylindrical stator (see accompanying sketch) the function of which is to secure an intimate mixture of the clear spent doctor with air. No heat is necessary after the emulsifying naphtha has been removed. Little or no attention is required. The cost of chemicals is about two-thirds that of the conventional process. The savings in chemicals and in recovered gasoline from four months' operation amounted to $7,444.12, assuring a quick pay-out for the installation.



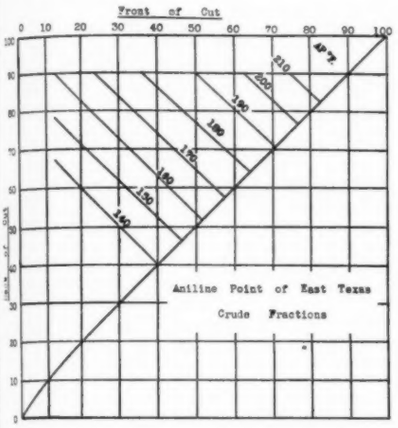
PETROLEUM CHEMISTRY

Chemical Composition of Petroleum Fractions.—Yu. K. Yuriev and P. I. Zhuravleb, in OIL & GAS JOUR., vol. 35 (1937), No. 43, pp. 65–70 (Amer. Chem. Soc. translation).

The general scheme of investigating the composition of petroleum fractions includes the following:

1. Method of determining the critical temperatures of solution in aniline of the fractions tested, followed by computation (using experimentally determined coefficients) of the aromatics, the total naphthenes, and the paraffin hydrocarbons.

2. The method of catalytic dehydrogenation originally developed by N. D. Zelinskii, which makes it possible to determine the content of hexahydroaromatic hydrocarbons in the fraction by converting them to aromatic hydrocarbons in the presence of catalysts.



The combination of these two methods makes it possible to determine directly not only the aromatics but also the hexa-hydroaromatic hydrocarbons in petroleum fractions boiling below 300 deg. C.; the content of naphthene hydrocarbons of the cyclopentane series is computed with the aid of the aniline coefficients; and the paraffin hydrocarbons are computed from the difference.

Besides this general procedure, there remains the question of computing the content of naphthene hydrocarbons with five-membered rings and paraffin hydrocarbons. There are two possible procedures available for this purpose, the preferred method being as follows:

Upon determination and removal of the aromatics the dearomatized fraction is subjected to catalytic dehydrogenation. The amount of aromatics formed thereby, after having been converted to C_nH_{2n}, will indicate the content of hexahydroaromatic hydrocarbons in the fraction. The content of hydrocarbons of the pentamethylene series is computed from the aniline point of the dearomatized product; the content of paraffin hydrocarbons is found by the difference.

Naphthenic Acids Direct from Crude Oils.—Victor Biske, in REFINER, vol. 16 (1937), No. 2, pp. 72–77.

Recovery of naphthenic acids as a by-product of petroleum refining operations has steadily increased in importance since its inception in Russia towards the end of last century. For many years the principal source of these acids was the alkali residue from the refining of kerosene in European refineries, principally in Russia and Roumania. Recently, however, owing to the greatly increased industrial outlet for naphthenic acids, the attention of American refiners has also been turned toward the production of this valuable subsidiary product. In practically all of the published processes for the recovery of naphthenic acids these latter have been obtained from petroleum distillates, and very largely from light distillates such as kerosene and gas oil ("solar oil") in which these acids tend to concentrate.

Whereas considerable attention has been paid to the recovery of naphthenic acids from various petroleum distillates there has been available very little data on the utilization of crude oil itself, prior to distillation, as a source of these products. While it is generally agreed that the removal of naphthenic acids from the crude oil would be a desirable procedure from the point of view of improving the quality of the subsequent distillates, and rendering them considerably easier to refine, to say nothing of the incidental value of the acids so recovered, there seems to be a general impression that such a procedure is impracticable on account of the formation of persistent emulsions of crude and soda solution which would lead to considerable difficulties in the subsequent handling of the oil. While doubtless this is true of a great number of crude oils it has, however, been found that, in the case of certain light crudes, treatment with alkaline solutions prior to distillation can be successfully carried out on a works scale.

Work recently carried out at an English refinery, operating on a light Peruvian crude oil, has shown that the washing of this crude, prior to distillation, with a caustic soda solution and subsequent separation of the alkaline extract for recovery of the naphthenic acids contained therein, is a perfectly practicable procedure and such treatment has now become routine practice.

The recovery of unrefined naphthenic acids from caustic soda extract of the crude oil is about 80 percent (original content is about 0.3 percent on weight of crude).

PETROLEUM PHYSICS

Separating Butenes from Butanes.—M. P. Matuszak and F. E. Frey, in IND. ENG. CHEM., analyt. edit., vol. 9 (1937), No. 3, pp. 111–115.

Practical separation of mixtures of hydrocarbons having four carbon atoms to the molecule, such as certain gas fractions from modern cracking operations, into a butene part and a butane part by simple fractional distillation is very difficult because of the small boiling point range:

	Deg. C.
Isobutane	−12.4
Isobutene	−6.7
1-Butene	−6.7
n-Butane	−0.6
2-Butene (trans)	1.0
2-Butene (cis)	3.7

Moreover, the order or arrangement of the hydrocarbons with respect to boiling point necessitates obtaining four fractions instead of only two.

Separation can be more readily accomplished by distillation in the presence of sulfur dioxide, which forms azeotropic mixtures with the following approximate boiling points at atmospheric pressure:

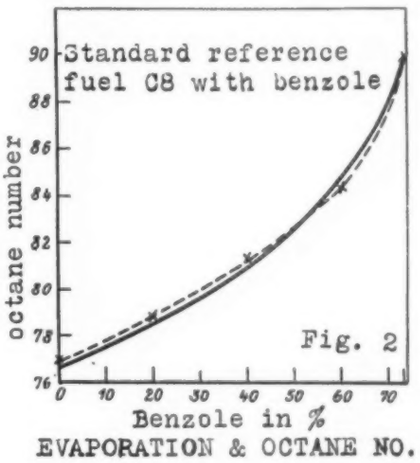
	Deg. C.
Azeotrope of isobutane	−24
Azeotrope of n-butane	−18
Azeotrope of 1-butene	−16
Azeotrope of isobutene	−14
Azeotrope of 2-butene (trans)	−14
Azeotrope of 2-butene (cis)	−13

The order of the azeotropes with respect to boiling point differs from that of the hydrocarbons themselves, because both butane azeotropes have lower boiling points than any butene azeotropes.

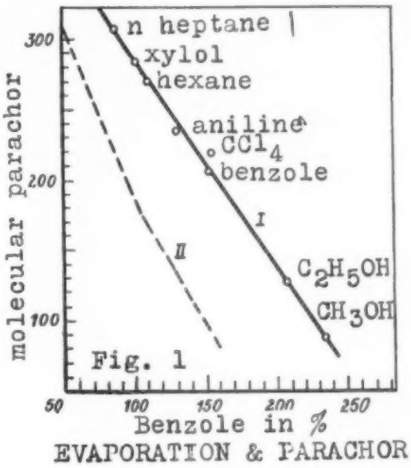
If sulfur dioxide is added to a mixture of four-carbon hydrocarbons in an amount equivalent to the azeotropes of the butanes present and if the resulting mixture is then fractionally distilled, the butanes can be separated from the butenes, for there is a difference of over 11 deg. C. between the boiling points of the highest boiling paraffin azeotrope and the lowest boiling of the olefins. Thus, *n*-butane and sulfur dioxide will separate into two liquid phases at −5 deg. C. and below, whereas iso-butene and sulfur dioxide remain in a single phase down to the freezing point of sulfur dioxide (−73 deg. C.).

The authors indicate some of the conditions to be fulfilled in a design of fractionating columns for practical application of the principles discussed.

Evaporation and the Knock Question.—O. Herstad, in OEL UND KOHLE, vol. 13 (1937), No. 9, pp. 208–212.



In a previous investigation the author showed that the view which regards combustion in a motor as exclusively a gas-burning process is erroneous; part of the fuel condenses as a liquid on the hot walls and then begins to re-evaporate. The question thus arises: what is the significance of this phenomenon on the utilization of the fuel in the motor?



As an essential step toward the solution of this question it was necessary to determine the evaporation curves of a number of liquids, not merely up to the boiling point but also between the boiling point and the flash point; a method and an apparatus for the purpose were devised. In this work there is observed a simple relation between the molecular parachor of the liquid and its *maximum* time of evaporation, as is shown in the accompanying diagram (Fig. 1). Curve I shows the results when using aluminium with 12 percent copper as the hot surface; curve II gives the results from a surface of perlitic iron, both heated to 500

deg. C. Mathematically, the relation is expressed by the formula

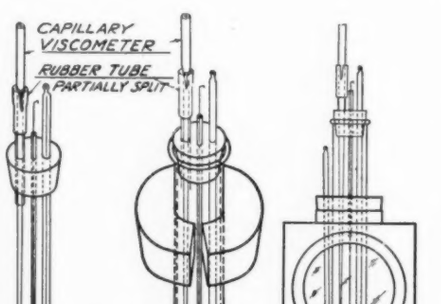
$$P = -\tfrac{3}{2}W + 435$$

where P is the molecular parachor and W the maximum time of evaporation of the liquid in seconds (this maximum time depends on rate of feed and quantity of liquid under the conditions of the experiment).

A further practical question is: if the change of phase depends on the parachor, what is the relation of the octane number to knocking susceptibility? This was studied by determining the evaporation times of the C.F.R. Standard reference fuel C8 to which increasing quantities of benzol were added; the results are pictured in Fig. 2.

Principle of the Suspended Level Viscosimeter.—Leo Ubbelohde, in IND. ENG. CHEM., analyt. edit., vol. 9 (1937), No. 2, pp. 85–90.

The suspended level is a term used to designate the hanging surface of a liquid which is formed at the point where a vertical capillary expands into a relatively large tube, so that a film of liquid is formed on the surface of the expanded junction. In this form the suspended level becomes an ideal auxiliary for hydrodynamic measurements, including viscosity measurements. When given suitable dimensions no correction other than the placing of a decimal point is necessary to convert time of flow to yield kinematic viscosity directly



in centistokes. The principle as applied to light gas oils and lubricating oils is explained in connection with the accompanying diagram.

At the lower end of the pipet-like bulb, A, having the two marks, m_1 and m_2, is attached a capillary which terminates in a wide tube, C, about 12 mm. wide. The lower, funnel-like end of the capillary is located on the axis of tube C and on this the suspended level is developed. Tube C is connected by a bent tube, g, to the lower bulb, B. This bulb is open to the atmosphere through tube 1, and tube C is in such communication through 3.

Bulb B is filled with liquid through tube 1 until the surface of the liquid lies about between marks x and y (not marked on the glass instrument). Suction is applied to tube 2, while the top of tube 3 is closed by a finger, and tube C, capillary 4, and bulb A are thus filled with liquid, as shown at the left. When tubes 2 and 3 are opened, air passes through tube 3 into C and immediately divides the liquid into two parts, as shown at the right. In this way the suspended level is developed on the lower end of capillary 4. The liquid meanwhile begins to flow out of bulb A through the capillary. However, it does not again fill C, but flows in a thin layer down its vertical wall and joins the liquid remaining in g and B. The time is determined during which the surface of the liquid drops from mark m_1 to mark m_2. The method of operation is thus as simple as can be imagined.

ASPHALT AND TAR

Investigation of Petroleum Products by the Clay Method.—H. Suida and H. Poll, in PETROLEUM, vol. 33 (1937), No. 10, pp. 1–2.

The authors give an account of the method employed by them for separating all clean oil and crystallizable petroleum constituents from the resinous and asphaltic constituents, without subjecting any of them to chemical alteration. The method is equally applicable to asphalts and any oily residues or distillates.

The petroleum fraction is obtained by dissolving five grams of the product in 500 cc. of low-boiling petroleum ether. If insoluble flocs appear these are filtered off, thoroughly washed with petroleum ether, dissolved in chloroform and the chloroform solution is set aside for the moment. The combined petroleum ether solutions are treated with decolorizing earth to obtain a light yellow color, the earth-treatment being repeated until all possible color is removed. Then the combined petroleum ether filtrates and washings are distilled and dried to constant weight.

The petroleum resins are obtained by extracting the used decolorizing earth at room temperature with the previously obtained chloroform solution, and the chloroform extract and washings are evaporated to near dryness; to remove the last traces of chloroform the product is dissolved in petroleum ether and again evaporated.

To obtain the asphalt resins the decolorizing earth from the chloroform extraction is now thoroughly extracted with pyridine and the extract concentrated in vacuum in an atmosphere of nitrogen or carbon dioxide to avoid oxidation. The last traces of pyridine are removed by pouring the extract into highly dilute cold hydrochloric acid, the asphalt resin is filtered off, washed with distilled water, taken up in hot benzol and the benzol solution evaporated and dried to constant weight.

To obtain the hard asphalt the decolorizing earth is finally treated with a 1 : 1 mixture of pyridine and carbon bisulphide, and after distilling off the latter the residue is treated as for the recovery of the asphalt resins.

The carbenes and carboids that are not differentiated by the Erden method are determined by a separate analysis as follows: 50 grams of the sample are masticated with 500 grams of carbon tetrachloride at room temperature until the carbenes and carboids have cleanly separated. The solution is filtered through a weighed filter, the residue is thoroughly washed with the solvent, dried, and weighed. The mixture of carbenes and carboids is now thoroughly washed with carbon bisulphide. The filtrate will contain the carbenes while the carboids remain on the filter.

Effect of Temperature on the Consistency of Asphalts.—H. G. Nevitt and L. C. Krchma, in IND. ENG. CHEM., analyt. edit., vol. 9 (1937), No. 3, pp. 119–122 (see also following abstract).

Since the absolute measure of consistency is viscosity, the authors point out that the change of consistency of an asphalt with temperature would be more logically measured as the change of viscosity with temperature. The objections to the usual empirical susceptibility indexes are discussed and the requirements of a satisfactory index outlined. The viscosity-temperature susceptibility coefficient is presented as a more fundamental viscosity-temperature index based on the A. S. T. M. viscosity-temperature formula and is mathematically represented as

$$S = 0.221 \frac{\text{Log}\left(\frac{\text{Log}\,(\mu_1+0.8)}{\text{Log}\,(\mu_2+0.8)}\right)}{\text{Log}\frac{T_2}{T_1}}$$

where S is the viscosity-temperature susceptibility coefficient and μ_1 and μ_2 are the kinematic viscosities at absolute temperatures T_1 and T_2. Graphically S would be the slope of a straight line connecting the two points obtained by plotting the viscosities of an asphalt, as obtained at two temperatures, on the A. S. T. M. chart D-341-32T. Data presented indicate that the viscosity-temperature susceptibility coefficient is applicable to a wide range of temperatures and viscosities.

In general the viscosity-temperature susceptibility coefficient appears best to meet the technical and practical requirements of fundamentally defining the viscosity-temperature characteristics for a wide range of consistencies and temperatures, which was not heretofore practical with the usual empirical consistency index. The asphalt viscosity index, although having fundamental significance, is limited to relatively narrow temperatures and viscosity ranges. It appears to be a satisfactory index when these are carefully defined. The fluidity index is the most consistent of the empirical indexes and appears to be, in conjunction with the indexes suggested by Holmes, one means of characterizing asphaltic materials.

The discussion of the merits of the viscosity-temperature susceptibility coefficient versus other indexes has no necessary bearing on the qualities of the asphalt for specific uses. Possibly some of the indexes reviewed do have merit in this connection, because other than consistency characteristics are involved. At present no correlation is suggested between the desirability of the product and the viscosity-temperature susceptibility coefficient, except where the change in viscosity with temperature is the only factor to be considered.

BOOKS

The Composition of Petroleum Asphalt.—By Oberbach and Pauer. Published 1937 by Allgemeinerindustrie Verlag, Berlin; 104 pp., with numerous figures and diagrams; 5.2 RM.

Owing to the fact that all research in the field of petroleum bitumen has been directed toward the physical properties, while the chemical end has remained comparatively little known, the authors of this book have made a wide survey of all research accumulated in this field.

A vivid description is given to the Pöll method of differentiation of ingredients and their influences upon the mixture, also showing the physical properties of the ingredients and their influence upon the functioning of the end product.

The authors show the corresponding changes of properties resulting from changes of volume of ingredients and emphasis is given to proper air exchange which has a material bearing upon the molecular structure, and all theoretical considerations are discussed.

The book is undoubtedly a valuable contribution for the guidance of further and possible research, as the pages are enriched with an accumulation of valuable data in the form of figures and facts concerning bitumens. It deserves the attention of all circles interested in asphalt.

PETROLEUM SUBSTITUTES

Effect of Vehicle on the Primary Liquefaction of Coal by Hydrogenation.—C. H. Fisher and Abner Eisner, before Amer. Chem. Soc., Chapel Hill Meeting, April, 1937.

The effect of vehicle in coal liquefaction, previously given little attention, was studied under comparatively mild conditions of hydrogenation (400 deg. C. and 67 atm. original hydrogen pressure). Twenty-one vehicles, consisting of single or a mixture of two organic compounds, were investigated. Pittsburgh bed coal obtained from the Bureau's Bruceton mine was used throughout. The organic compounds employed were selected on the basis of certain outstanding properties such as polarity, aromaticity, paraffinicity, depolymerizing action on coal, and tendency to lose hydrogen at high temperatures. From the results obtained it is possible to draw several conclusions regarding the requirements of a satisfactory vehicle.

Previous claims that tetralin is a good dispersion medium were confirmed. The only other hydrocarbon that was effective is methylnaphthalene which is similar to tetralin in that it is partly aromatic and partly aliphatic. Completely aromatic hydrocarbons (naphthalene and diphenyl) and saturated hydrocarbons (decahydronaphthalene and hexadecane) were poor vehicles. The presence of polar compounds, such as phenols and amines, in the vehicles was beneficial. The products formed in highest yield were pitches, which melt at moderately elevated temperatures. Elementary analyses of these pitches indicated that hydrogenation had raised the carbon and hydrogen contents, lowered the sulfur and oxygen contents, and caused little change in the nitrogen content.

PETROLEUM ECONOMICS

Rôle of Price in the Functioning of Proration.—J. E. Pogue, before Amer. Inst. Mining Engrs., New York, 1937.

A primary objective of all economic activity is equilibrium. The plane upon which equilibrium centers may shift in the course of time, but equilibrium itself is the point of departure and the point of return. If an industry is in equilibrium, that industry is operating effectively. The motivating forces of an industry—profits or the common good—are not to be confused with the prerequisite of equilibrium, but this mistake is often made. The producer is dominated by the profit motive; the consumer, or his collective representative, by the general welfare motive. No one is the advocate for equilibrium; that status is supposed to be arrived at automatically.

If it be accepted that industrial equilibrium is a sine qua non and that a primary purpose of price is to contribute to that end, what should be the reasoning of the buyer when he names a price? The following principles are listed for consideration:

1. The price should be designed to bring forth the supply properly needed;
2. The price should provide the degree of stimulus for exploration that seems appropriate in light of the prevailing discovery rate, potential production, and oils in storage;
3. The price should not normally be out of line with the realization obtainable from a barrel of crude;
4. The price should not be such as improperly to retard or accelerate demand, the meaning of "improperly" varying at different phases of the cycle;
5. The price should bear such relation to cost as to promise a proper flow of capital to and from the industry.

It will be immediately observed that the criteria outlined are general and are not subject to precise determination. Furthermore, several of them involve future considerations, and this is the reason why price nominations must be experimental and the price structure itself left free to back and fill to arrive at an equilibrium level. It will be observed, further, that these criteria do not differ substantially from those that would appear desirable under nonproration, but the following important qualification should be held in mind. Proration has contributed a rigidity to the price structure and an attitude of mind regarding its alteration, that are working against the functional manifestation of price; and this development presents a two-fold liability. Firstly, in the event of overdiscovery, the way is left open for the development of sustained drilling campaigns leading to the loss of equilibrium. Secondly, in the event of underdiscovery or of inflationary demand, the way is left open for the inhibition of the price changes needed to facilitate transition to a new plane of equilibrium. In short, the petroleum industry, now as well as formerly, stands in need of a flexible price structure attuned to directing the forces of price to the safeguarding of equilibrium.

Third Grade Gasoline on the Decline.—T. F. Smiley, in OIL & GAS JOUR., vol. 35 (1937), No. 44, pp. 29–34.

Changing conditions have gone far to close the price gap between the third-grade and the higher-bracket gasolines. Orderly operation has supplanted chaos in East Texas. The enormous quantities of illegal crude stored in open pits and tanks have disappeared. Hot oil and its derivatives have vanished, and with them has gone the former low-price lure of third-grade gasoline, which now usually sells for only two cents less than the regular, with its distinctly better performance.

One of the most telling reasons for the fading popularity of third-grade gasoline—really the most important reason of all—lies in the demand of the modern automobile for a high-octane fuel in order to get the best performance from it. Most of the new cars moving onto the highway from the manufacturing plant are designed to use a gasoline of 70 octane or higher. Every time an old car is junked and a new model takes its place the demand for high-octane motor fuel is increased and the position of third-grade quality recedes; for there is a diminishing disposition on the part of the owner to use the cheap fuel even though he is on a long drive on level roads, when he might get along fairly well with a low-octane gasoline.

The steadily climbing compression ratio of the automobile presents the principal reason for the declining demand for low-octane gasoline. Here is shown the average compression rise of American passenger cars from 1925 to 1937, with the accompanying increase in maximum horsepower and horsepower per cubic inch:

Year	Maximum horsepower	Horsepower per cubic inch	Compression ratio
1925	59.046	0.234	4.40
1926	60.67	0.246	4.47
1927	64.26	0.256	4.55
1928	72.18	0.285	4.86
1929	81.37	0.311	4.99
1930	90.97	0.336	5.15
1931	93.12	0.342	5.23
1932	103.5	0.359	5.29
1933	106.49	0.364	5.57
1934	111.21	0.384	5.72
1935	109.70	0.399	5.99
1936	113.20	0.408	6.16
1937	115.10	0.416	6.25

Some operators of fleets of taxicabs and light trucks have reduced the compression of their engines and adapted them mechanically to run satisfactorily at slower rates of speeds in city streets on third-grade gasoline. However, as the price spread between third-grade and regular narrows there is a lessened tendency to resort to this species of economy.

Barring discovery of new pools yielding high-gravity crude, which lends itself easily to skimming operations, many refiners will have to install better facilities for cracking and reforming operations if they are to remain in business, thus further lifting the general octane level of gasoline.

Modern Oil Refining Policies.—Oskar Tokayer, in PETROLEUM PRESS SERVICE, vol. 4 (1937), pp. 145–148.

The Irish Free State is one of the latest of small nations infected with the notion of establishing a domestic oil refining industry, in the face of the decision of leading oil companies not to participate in the scheme. The oil companies reason that no local refinery could produce the range and quality of products required by the Irish market except at an extravagant, if not fantastic, cost. There would be no advantage to the national defense, and the plant might become obsolete in a year or two.

The proposition to establish a national Irish oil refining industry has not yet fully materialized, although a company has been floated for the purpose, but it is interesting as a sign of the times. It was, no doubt, the example of France in establishing an oil refining industry which led to the development of a widespread tendency to encourage the erection of domestic refineries rather than to look for oil products, as previously and more economically, to the output of the large refineries erected in the producing countries or adjacent shipping centers. Before the French refineries were in full operation, Italy followed suit, while Belgium also passed legislation to encourage the erection of local refineries. Even countries with so small a consumption as Bulgaria have embarked on domestic refining policies, not to mention Portugal.

Not one of these countries which followed France's example has any crude oil production worth mentioning which might provide justification for a national refining industry. In each case the fundamental mistake has been made of supposing that the exact range of oil products required can be easily obtained from imported crude, although the scale of refining operations must necessarily be of a restricted character. Nor is consideration given to the question whether crude can always be made available in the quality required. It is assumed that, once a certain measure of independence of imported finished products is achieved, the country possesses greater security against emergencies. This is regarded as justifying not only the costs of refinery construction, but also the considerable sacrifices necessary for their continuous operation, since no refinery could operate successfully in these countries without a substantial measure of state protection.

In view of the fact that this tendency towards domestic oil refining is, under the pressure of official oil policies, still spreading, one is tempted to ask again whether anything has occurred to modify the established principle in the oil industry, viz., that the refining of finished products from crude oil can be most efficiently and economically done in the huge plants located near the producing centers. A close examination of this question, however, shows that, in its essential features, this principle still holds good.

USE OF PETROLEUM

Influence of Atmospheric Humidity on the Octane Number Determination.—J. R. MacGregor, in OIL AND GAS JOUR., vol. 35 (1937), No. 37, p. 164.

The influence of atmospheric moisture on the octane number determination is very consider-

able. Variations in humidity have a marked effect in comparisons of the same light motor fuels in different places or in different seasons of the year. This applies to fuels of different compositions, as gasoline-benzol mixtures, leaded gasolines and synthetic hydrocarbons mixed for testing purposes.

In experiments with a C.F.R. motor the author devised an apparatus for holding the combustion air at a constant degree of humidity, and with this arrangement he ran tests with straight-run gasoline, straight-run gasoline-benzol mixtures, cracked gasoline, leaded gasoline and octane-heptane mixtures. The octane numbers were determined by the bouncing pin method. The standard of comparison was a gasoline-benzol mixture with an octane number of 68 and air with a content of 13.5 grams of water per kilogram. The experiments covered a range of moisture content from 2 grams to 30 grams per kilogram of air. Within the limits of 2 to 23 grams of moisture, the octane number of a mixture of octane and heptane (67.5 percent octane and 32.5 percent heptane) varied over a range of 5.1 octane numbers; in a mixture of straight-run gasoline-benzol (55 and 45 percent) the range of variation was 7.9 octane numbers, which was also the range of variation of a 100 percent cracked gasoline.

Alteration of the atmospheric pressure by about 25 mm. of mercury (the degree of humidity remaining constant) produced variations between 2.5 and 3.4 octane numbers. This shows that variations of humidity are of more importance than variations of pressure.

The results obtained in this investigation are of significance in that they tend to explain the varying results of octane number determinations reported by different observers working in different places.

Note.—The influence of atmospheric moisture on thermal efficiency of fuels is very well understood in the smelting industry, where the air entering the blast furnaces is previously dried. The reason is that an appreciable amount of the heat developed by burning the fuel is required to warm up the vaporous water to the maximum combustion temperature. Ed.

Lubrication Requirements of 1937 Rear Axles and Transmissions.—G. C. Mather, before Northwestern Petroleum Assoc., Minneapolis, January, 1937; Petrol. Marketer, 1937, No. 9.

Motor car manufacturers, appreciating the necessity of closely guarding the quality of hypoid lubricants, have found it necessary to violate their firmly established policy of not approving any specific product. At present, they are using three methods to assure correct lubrication of hypoid rear axles:

(1) Insistence on car owner obtaining hypoid lubricant refill from car dealer only, on penalty of cancellation of warranty for failure to do this.

(2) Issuance of lists of approved brands of hypoid lubricants for use in the makers' axles.

(3) Instructing owners to use only powerful-type lubricants specially designed for hypoid gears and leaving it up to the oil company to provide such a product.

Requirement (1) will doubtless be modified as general distribution of hypoid lubricants is accomplished. At any rate, matters have now gone to the point where normal mineral oils should not be dispensed for steering gears, transmissions, or rear axles, of passenger cars. Mild E.P. lubricants having suitable properties should be used exclusively. The only exceptions are:

(1) Over-drive transmissions.

(2) Hypoid axles.

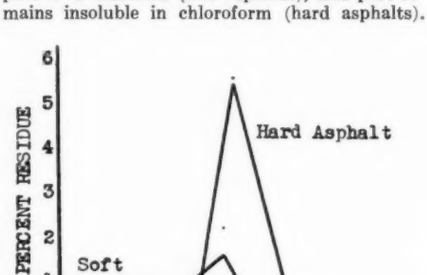
For over-drive transmissions, the manufacturers recommend only straight mineral oils falling in the classification for motor oils. They know that poorly made, mild E.P. lubricants that oxidize readily and contain insoluble matter, will make their device inoperable. When well-made, permanent, oxidation-resistant, mild-type, E.P. lubricants are in more general distribution by the smaller oil companies, this restriction will doubtless by removed.

For hypoid axles, only specially designed and carefully made ultra-powerful, lead, active-sulphur lubricants, complying in every respect with leading car makers' recommendations must be used.

Several large oil companies now confine their gear lubricants to mild type E.P. lubricants and hypoid lubricants. It is expected that this practice will increase steadily until normal mineral oil lubricants will no longer be used for automotive gears.

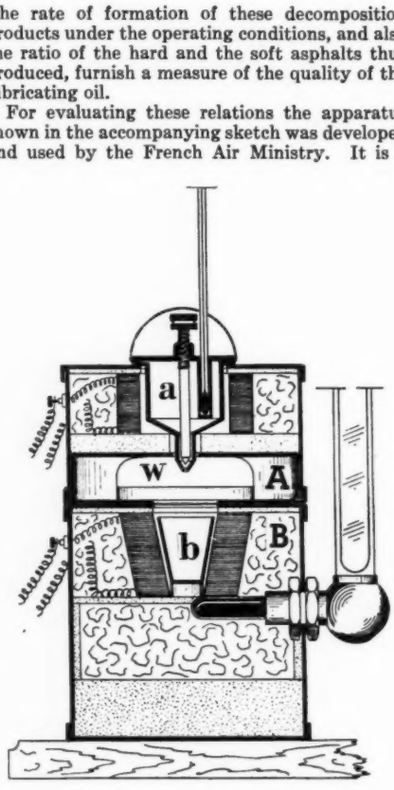
Contribution to the Lubrication of Internal Combustion Engines.—J. Daiman, in REV. PETROL. No. 726 (1937), pp. 337–339.

After a lubricating oil has been used for some time in an internal combustion engine, certain decomposition products are formed which are left as an insoluble residue when the used oil is dissolved in petroleum ether. When this insoluble residue is then treated by itself with chloroform, part of it dissolves (soft asphalts), and part remains insoluble in chloroform (hard asphalts).



The rate of formation of these decomposition products under the operating conditions, and also the ratio of the hard and the soft asphalts thus produced, furnish a measure of the quality of the lubricating oil.

For evaluating these relations the apparatus shown in the accompanying sketch was developed and used by the French Air Ministry. It is a cylindrical vessel composed of an upper part *A* and a lower part *B*. The lower part contains an electric heating element surrounding a 20-cc. crucible of porcelain or metal (*b*). The upper part contains a small oil reservoir (*a*) wherein oil can be electrically heated to about 100 deg. C.



In operation the lower part *B* is brought to any desired constant temperature between 200 and 500 deg. C. and the oil, previously heated in (*a*) to 100 deg. C., is dropped into crucible (*b*) at the rate of one drop per 10 seconds, as observed through the window (*w*). Dropping of the oil is continued 15 minutes, after which the constant temperature is maintained for another 15 minutes, whereupon the apparatus is allowed to cool, the crucible is withdrawn, the contents extracted with petroleum ether, and the soft and hard asphalts separated by chloroform extraction. The experiment is repeated over a temperature range of up to 450 or 500 deg. C. so that the relevant curves can be drawn as shown in the accompanying graph, where the percents of soft and hard asphalts produced are shown as functions of the temperature.

Results obtained with this apparatus make it advisable to warn against lubricating oils showing above eight percent of chloroform insolubles at a temperature below 300 deg. C. It will be noted that this test differs from the Conradson test in that the latter registers merely the end result of carbonization at the maximum temperature, whereas the present test registers the progressive result over a wide temperature range.

The 15 minutes of continued heating after dropping of the oil ceases is important as registering what occurs when an engine is stopped and begins to cool; it is in this period of quiescence of the hot engine that much of the decomposition of the oil occurs, as has been shown by examination of aviation engines.

GENERAL

Discovery Rates of Oil Finding.—Wallace E. Pratt, before Amer. Assoc. Petroleum Geologists, Los Angeles, March, 1937.

Although at the moment there is an inconvenient surplus of oil in storage and in reserve, it is necessary that new sources of oil be found in order to assure continuance of future supplies. At what rate new oil fields will henceforth be discovered is problematical. What the author has to say on the subject is summarized under nine heads:

Our discovery rate in oil-finding was rather uniformly accelerated as the industry expanded through the period subsequent to the year 1900 until, over the years 1926–1930, it reached a peak more than double our current rate of consumption. Thereafter it declined sharply until it averaged, over the next five years, only about 70 percent of our current rate of consumption.

This is true whether discovery rate be measured in terms of barrels of reserves found, or in terms of major oil fields found.

Geological exploration has been dominantly our most effective finding method in the past. It has been less effective over the past ten years than it was previously, and has definitely yielded leadership to geophysics over the last five years.

Whether the failure of the discovery rate to maintain its earlier pace is to be explained as an effect of the recent industrial depression, as is generally assumed, or by the inadequacy of our finding technique to cope with increasing difficulty of oil-finding, may be debatable, but the evidence supports the latter as a major contributing factor.

We now drill fewer dry holes per major discovery than we did formerly, but this trend may be arrested or reversed in future exploration.

Our proven reserves, now about 13,000,000,000 bbl., are probably adequate or even excessive, viewed solely as a reserve supply, but they should

be maintained at their present level to permit of production in an efficient manner and at the same time at the rate necessary to meet consumption.

Our finding technique definitely needs to be strengthened. Merely finding structural traps at greater depths and drilling deeper wells to tap them, as we have been doing in recent years, promises too little to permit us to rely upon it alone.

The most likely means of improving our oil-finding accomplishment is embodied in Levorsen's suggestion, made a year ago, that we initiate an intensive search for "stratigraphic traps."

This enterprise, if adopted, may be expected to cause an increase in the ratio of dry holes to discoveries, and to quicken the demand for expert geological supervision. But it should accomplish its purpose; namely, the discovery of important additional reserves of petroleum.

INTERMEDIATE ALLOY STEELS FOR HIGH-TEMPERATURE APPLICATION.—S. D. Williams, in REFINER, vol. 16 (1937), No. 3, pp. 117–118.

Economic balance between life, service and cost may frequently be obtained in the case where plain carbon steel tubes are not entirely suitable, yet where 18-8 steel tubes are too expensive, by using an intermediate or low alloy steel. 4–6 percent Cr steel with 0.50 percent molybdenum usually lasts approximately five times as long as carbon steel in cracking furnace tubes.

Both silicon and aluminum have demonstrated their value in increasing the oxidation resistance of steels containing chromium. Silicon alone will protect plain carbon steels against serious oxidation up to 1,200–1,250 deg. F., and where chromium is added this effect carries on to still higher temperatures. Tests show that two percent of silicon in a six percent chromium steel will assure approximately the same resistance to oxidation in air as is developed by a 25 percent Cr steel at 1,500 deg. F.

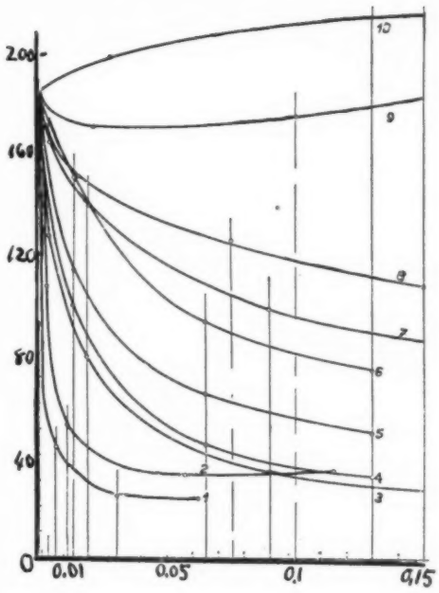
A 4–6 percent Cr-Mo steel with 0.50 percent of silicon shows reasonably good resistance up to 1,250 deg. F. The Sicromo 1, 2, 3 and 5 steels all show substantial increases in oxidation resistance at 1,000 deg., 1,250 deg. and 1,500 deg. F. No chromium is used in Silmo, yet at 1,200 deg. F. this steel shows approximately the same resistance to oxidation as does the 4–6 percent Cr-Mo steel.

When selecting tubes for use in refinery service, it is essential that service requirements be studied in connection with the properties of the steels available. Maximum efficiency and economy may frequently be secured by selecting different steels for different locations in the same furnace. No one steel is most suitable for all applications.

Thus it will be seen that best results and maximum economy may be secured by cooperation. The tube manufacturer, the designer and the user should all cooperate in solving the technical problems now involved in refinery design. A slight modification in design may mean a major change in the conditions under which the tubes must function, or the use of a different alloy than the one first contemplated may mean a substantial reduction in operation and maintenance costs.

EXPERIMENTS WITH ACID INHIBITORS. I.—J. Forman, in ZEIT. ZUCKERIND. CZECH. REP., vol. 61 (1937), No. 25, pp. 193–197 (see also following abstract).

Wherever an attempt is made to attack lime carbonate or other decomposable lime compounds with hydrochloric acid in the presence of metal (especially iron), the iron will be attacked also. This situation arises when hydrochloric acid is used to dislodge incrustations in steam boilers, heat exchangers, etc. (and, of course, in the process of acidizing oil wells in the presence of casing. Ed.). It is therefore desirable to add to the acid some substance that would inhibit its action on iron without impairing its action on the lime com-



pounds. In this study four groups of substances were taken into consideration:

1. Inorganic salts as the chlorides of calcium and ammonia, the sulphates of ammonia and iron and potassium ferrocyanide; these generally intensify the action of the acid and are to be avoided.

2. Oxidizing substances, as the nitrate and bichromate of potassium, chloramine, etc., which greatly increase the solution-velocity of iron; these also are to be avoided.

3. Non-conducting substances that increase the velocity of the liquid, decrease the mobility of the ions, and hence diminish corrosion.

4. Organic substances, such as formaldehyde, aniline, pyridine, quinoline, toluidine, xylidine and triamylamine considerably reduce the corrosion of iron. The last named substance, triamylamine, is the most effective of all; representing the corrosiveness of straight 10 percent hydrochloric acid by 100, the corrosiveness of the same acid with not more than one gram of triamylamine per 100 cc. is only 13. This action of triamylamine was first noted by Mann, Lauer and Hultin (Ind. Eng. Chem., 1936, pp. 159 and 1048, which see). In general, the most effective acid inhibitors are the organic amines. The relative effectiveness of these substances is indicated in the accompanying diagram, wherein grams of nitrogen are shown on the abscissas, and milligrams of dissolved metal on the ordinates. The ten curves represent: (1) triamylamine; (2) xylidine-toluidine; (3) crude pyridine; (4) pure pyridine; (5) meta-toluidine; (6) ortho-toluidine; (7) para-toluidine; (8) aniline; (9) ammonium sulphate; (10) ammonium chloride.

TECHNICAL MEANS OF INHIBITING ACID CORROSION. II.—J. Forman, in ZEIT. ZUCKERIND. CZECH. REP., vol. 61 (1937), No. 27, pp. 209–213 (see also preceding abstract).

In pursuance of his studies of means for reducing the corrosion of iron and brass tubes, during the removal of incrustations from evaporating surfaces by treatment with hydrochloric acid, the author found that either sweet beet cossettes or exhausted beet pulp is an excellent material for the purpose. For this use the pulp is prepared by digesting it for about 12 hours with concentrated hydrochloric acid. The proportion of pulp to strong acid is about 1 or 2 to 5; a small addition (about 0.0005 percent) of copper sulphate is made to the acid. On dilution with water there is obtained an acid solution that dissolves calcium carbonate in the cold at an even somewhat faster rate than the pure acid of the same concentration, whereas its corrosive action on iron is reduced about 90 percent. The inhibition of corrosion of brass is considerably weaker, but this is not relatively of great importance, as brass is naturally less subject to acid corrosion than iron.

The effectiveness of beet pulp for this use depends on the time of digestion with strong acid. If the time of digestion is too long (two or three days) the pulp is carbonized and loses its inhibiting power. It seems that the pectins of the pulp are hydrolyzed into colloidal substances which are later destroyed by the acid. For this reason the digestion should be limited to about twelve hours.

VARIATION OF OIL CHARACTER IN THE GULF COAST AREA.—Donald C. Barton, before Amer. Assoc. Petroleum Geologists, Los Angeles, March, 1937.

Comparison of the A.P.I. gravity and percentage content, respectively, of the crude oils of Miocene, Oligocene, and Eocene Gulf Coast crude oils from depths of 3,000 to 5,000 ft. with the oils of corresponding age from depths of 5,000 to 7,000 ft. shows that the A.P.I. gravity of the fractions and the percentage content of the lower boiling fractions tend to increase with depth and age. The base of both the lower and the higher boiling fractions tends to change with increasing depth and age from naphthenic to intermediate, and almost to paraffinic. In order of similarity, those age-depth groups of crude oils are arranged: Shallower Miocene, Shallower Oligocene, Deeper Miocene, Shallower Eocene, Deeper Oligocene, Deeper Eocene.

Variation of the Gulf Coast crude is consistent with transformation under the effects of time and some factor or factors proportional to depth below the surface, but is inconsistent with alteration under the effects of time and some factor or factors proportional to nearness to the surface. The theory of evolution of the Gulf Coast crude oils from heavy naphthenic ancestral oils under the effects of time and some depth factor or factors, therefore, still is advocated. The evolution consists in, (a) decrease of the specific gravity of all but the lowest boiling fractions, (b) increase in percentage content of the lower boiling fractions, and (c) transformation of the base from naphthenic toward and almost to paraffinic. Cracking cannot be the main reaction in the evolution. Methanation possibly plus cracking is regarded as the most plausible explanation of the evolution.

This law of the variation of crude oil is only one of many; and occurrences of one type do not preclude the existence of other types.

THE OIL CORROSION PROBLEM.—Gustav Egloff, in REFINER, vol. 16 (1937), No. 3, pp. 99–100.

The destructive forces of corrosion are ever present wherever iron or steel is used. In 1936 the corrosion invoice of the oil industry was in the neighborhood of $250,000,000. In production, in transportation, in storage, in refining, in utilization, there are various specific problems of corrosion to be faced. Innumerable remedies have been proposed, but the problem is still with us. In many phases of the oil industry certain alloys resist corrosion and last a long time; but on the one hand such alloys are high priced and on the other hand the rapid rate of obsolescence in the oil industry makes the replacement of all equipment in the oil industry not only an enormous expense, but one which is needless in view of the rapidly changing equipment design in many cases. However, it would appear that it is along this line that a fundamental solution of the problem may be reached. New alloys of excellent physical and chemical properties are continually being developed by the metallurgists, and it is to be hoped that through research low-priced alloys will be found to do what the high-priced ones are today accomplishing in the oil industry.

U. S. S. R.

Official Figures for Soviet Oil Operations

	Crude Production (bbl)	Daily Average (bbl.)	Run to Stills (bbl.)	Drilling (feet)
1937				
January	16,100,000	519,355	14,750,000	480,000
February	14,600,000	521,430	12,800,000	410,000
March	15,800,000	509,608	13,900,000	522,100
Total 3 Mos. 1937	46,500,000	516,665	41,450,000	1,412,100
Total 3 Mos. 1936	47,788,300	525,143	41,248,400	1,636,396
Total 1936	191,911,200	507,950	171,269,500	6,952,222
Total 1935	176,688,100	497,713	146,705,000	4,858,465
Quota 1935	212,310,000	581,672	171,500,000	5,214,000
Quota 1936	213,500,000	584,931	175,000,000	7,100,000
Quota 1937	225,120,000	616,767	191,500,000	8,200,000

Crude conversion: seven barrels = one ton.

THE SOVIET oil industry has made practically no headway during the first quarter of 1937, although this does not preclude the possibility of later improvement. It is most likely that total crude production for 1937 will compare favorably with 1936 or even rise to the 200,000,000 bbl. mark. Soviet oil reserves have been materially increased and a number of new wells in properties adjacent to Baku, Grozni, Maikop and elsewhere have been tested and given strong commercial flows, but development proceeds slowly and it may take some time before practical results will be forthcoming. In the meantime the oil industry is lagging behind the plan for the first quarter, and is behind the corresponding figures for last year.

The operating quota for the first quarter of 1937 included 59,400,000 bbl. of crude and about 2,150,000 feet of drilling. During none of the three months were operations instrumental towards accomplishing this task. Crude production has been running between 76 and 82 percent of the plan and averaging about 80 percent for the quarter with drilling of some 65 percent of the plan. These operations during the first quarter of 1937 amount to about 93 percent of the crude production during the corresponding period of last year, and about 86 percent of the drilling accomplished.

Baku oil fields have operated during March at 87–88 percent of the plan and while only Lenin, Kirov and Ordzonikidze oilfields were able to show plan fulfillment for the month and even some excess over plan figures during individual days. All other Baku oilfield groups were lagging behind plan with the indices of plan fulfillment shown in the accompanying table.

Oilfield Plan Fulfillment

Oil Fields	Percent
Stalin group	95–100
Kirov	100–101
Ordzonikidze	104–110
Lenin	95–99
Molotov	79–82
Artems	77–78
Kaganovitch	75–78
Aliati	65–76
Asisbekov	72
Kergez	40–46

The total for all Grozni was 71–78 percent of the plan of which the October fields show 83–88 percent, Molgabek 75–85 and Daghestan 14–26 percent. All other Soviet fields show following plan fulfillment:—Maikop 72–77 percent, Bashneft 56–72, Emba 79–80, Kalinin 84–106, Voroshilov 13–58, Sakhalin 79–86 and Turcomaneft 38–75.

From the point of plan fulfillment for the first quarter of 1937 no branch of the Soviet Heavy Industries was able to show satisfactory results. Fulfillment of plan by oil and gas industry was 17.1 percent and 12.3 percent by drilling against expected rate of 21.6 percent.

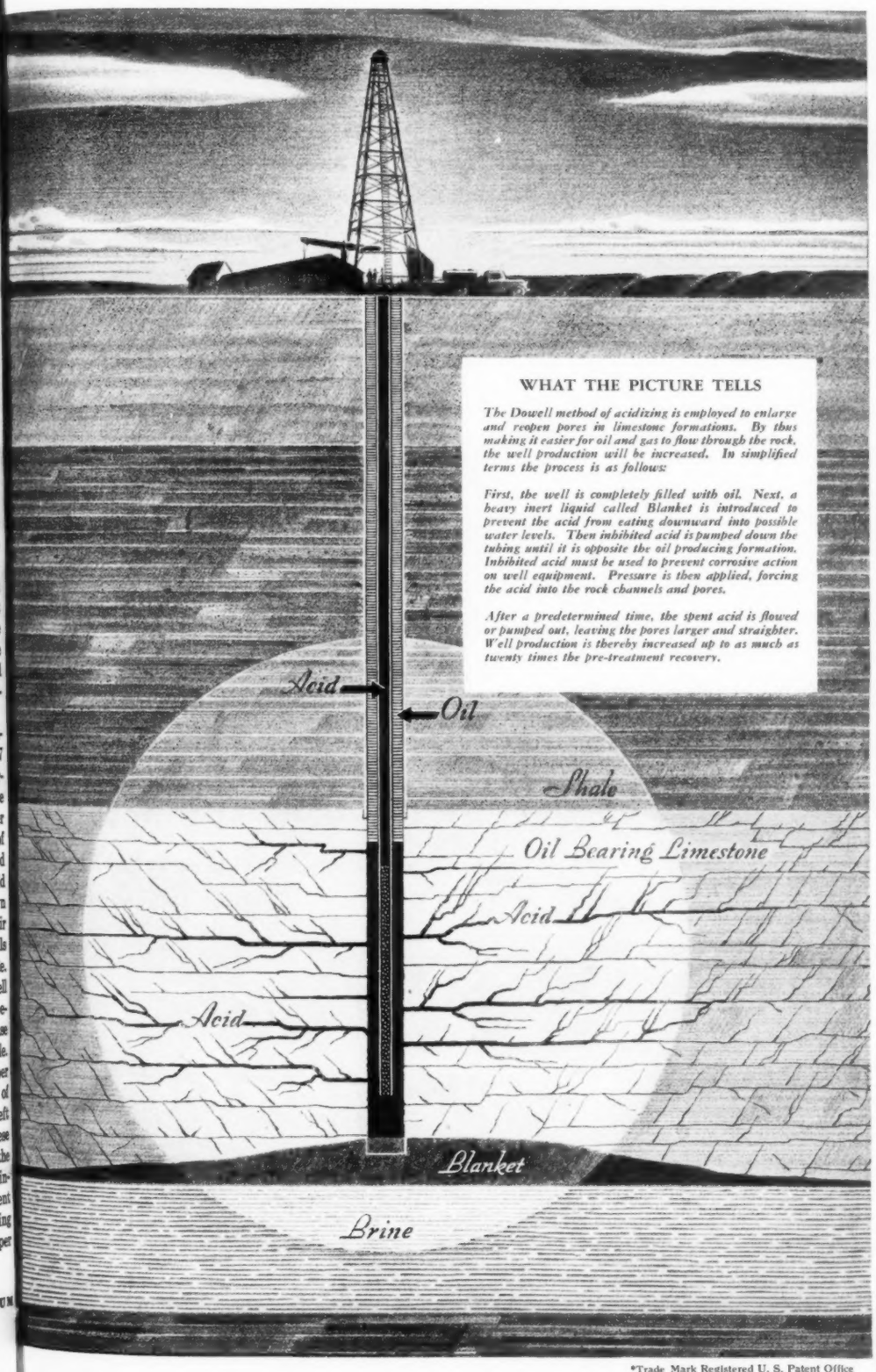
Commenting on Russian oil operations, the Soviet paper ZA INDUSTRIALIZATIU, in several editorials, has bitterly criticized management of the individual oil operating units as well as the heads of Glavneft for failure to take the necessary steps in introducing Stakhanov tempo of operations in order to turn the tide of events. Needless to say the Soviet press or their representatives have opportunity to get a thorough insight into conditions prevailing in the nation's oil industry. Furthermore, it has played fair, although it scolded and grumbled when the necessity arose, it has also been non-partisan by giving the same heads of oilfields credit when it was due. Has, however, the Soviet press at any time given some consideration to the fact that the blame for shortcomings may be laid on the system in general, rather than the managers in particular?

Editorials of ZA INDUSTRIALIZATIU ask:—

"Why have the drillers of Baku retreated from positions conquered in the past? Glorious accomplishments of Stakhanov brigades are still vivid in memory and the ink used in describing the glory has not as yet dried, now—defeat. Crude production is deep in arrears against plan and the indebtedness of the oilfields is jeopardizing plan-fulfillment of Soviet national economy. Individual oil field managements attribute the shortcomings to blizzards, and other adversities. Baku arrears against plan in crude production as well as in drilling, however, became an alarming factor long before bad weather has set in and continues even after bad weather has ceased to affect operations. Early in January a large number of producing wells which had recently been repaired again required attention. Obviously they ceased to produce because the quality of repairs was, and still is, poor. At the end of March the total number of wells in operation at Baku was 200 less than at the beginning of the year. February brought no improvement in drilling operations. Completions were only 50 percent of expectation and at individual fields as little as 15 percent of requirements were completed, and then drilling was of poor quality, low speed per table per month and insufficient footage was effected. March has brought no appreciable change and while indebtedness of the oil fields in crude production is continuing to increase, arrears of plan have grown into a physical and chronical ailment for which there seems to be no justification. Alibis of bad weather, lack of electrical power, inability to utilize gas motors, of which there is an ample supply, but insufficient or no gas lines, insufficient supplies of pipe, cement, barytes or other materials," the paper says, "are but subterfuge; the real and actual causes of the oil industry's ills are to be found in mismanagement and poor organization, in laxity of labor discipline, inability to put the right man in the right place for the right job, and lack of expediency to make the best of labor, supplies, equipment, and transport facilities, all of which are available in sufficient quantities.

"Grozni operations are on the downgrade. Plan fulfillment amounted to 76.7 percent in January, in February 74.1 percent, and in March (uncompleted at time of writing) 73.6 percent. In the October fields of Grozni 164 wells are idle and of these 50 percent at least could be operated after effecting slight repairs. At old Grozni field over 300 wells were shut-down due to tardiness and inefficiency of repair work, upon completion of which the wells invariably produce much less crude. Causes of Grozni shortcomings are well known. Labor productivity is poor because discipline is lacking and this because organization is lax and irresponsible. Production curve is descending," the paper says, "not alarming the management of October and Molgabek fields who have left everything to fate and believe that these shortcomings will be removed during the second quarter. Drilling at Grozni, including Daghestan, fulfilled 67.6 percent of plan in January and 46.3 percent during February. Speed of drilling per table per

VITALIZING OIL WELLS VIA *Chemistry*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Shale
Oil Bearing Limestone
Acid
Acid
Blanket
Brine

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month averaged 5,040 feet during December, 1936, 3,584 feet in January and 2,200 feet in February. Completions and wells spudded-in were 50 percent of expectations, or even below. The causes are neither geological nor meterological shortcomings—the management is to be blamed. Of course, there is some shortage of timber or of cement, but why not utilize timber and cement from rigs and wells where drilling has been completed?"

While crude production has become stabilized at the rate of about 25,000,000 tons per annum since 1931, exports have declined from 6,000,000 tons in 1932 to about 2,700,000 tons in 1936 and domestic consumption has grown from about 8,000,000 tons in 1930 to about 18,000,000 tons in 1936. With the formidable growth of industrialization of the country at large and no correct official figures on home consumption being published, any estimate on fuel requirements for industrial use or for railroads, agriculture, aviation—civil and military, defense purposes and general use, is only a guess and such a guess has to be pieced together from official information which is being published by the Soviets for home consumption rather than for general statistics. A considerable growth of domestic consumption of petroleum is evidenced from the sharp criticism which the Soviet press in general and ZA INDUSTRIALIZATIU, organ of Soviet Heavy Industries, has of recent voiced against all sorts of fuel wastage. This paper states that a decisive increase in production of coal and oil, at all costs, is but the first step to alleviate the stringency of the situation. A second step of no less importance and hand-in-hand with an increase of production is to effect an economy of consumption together with elimination of wastage by evaporation in storage and transportation and by rationalization of fueling. When total use of all fuel equivalents in 1937 for the country at large is estimated at about 200,000,000 tons, an economy of only one percent represents a substantial quantity.

At present hundreds of Soviet fuel consumers not only overlook the necessity of fuel rationalization but aggravate the situation by extravagant wastages of fuel.

Soviet industries where fuel consumption is of more or less specific nature and limited by specific allowables do much injustice to allowables and schedules when their rates of fuel consumption are compared with corresponding figures of consumption in other countries. The forge and blacksmith divisions of the Cheliabinsk Tractor works, the Kirov and Luberetzki works, as well as many other Soviet plants require from one-and-a-half to twice as much fuel per ton of output as do the corresponding rival plants of U.S.A. or Europe. All open hearth furnaces in Soviet metallurgical enterprises consume 40 percent more fuel than any of their rival enterprises in other countries.

Soviet metallurgy has undoubtedly made large strides of progress in the way of modernized processes. While ranking first in the list of Soviet fuel consumers, it ranks also first among those who waste fuel. Losses are exorbitant and consumption is far above plan. Among Soviet plants where wastage of fuel ranks high are named the highly modernized plants such as Djersinski, Lower Saldinsk, Dobrianski, Petrovski, Makeevka and many others.

Libknecht works had reported 13,500 tons of fuel losses in evaporation while in storage in 1936 and these losses are exactly 11.5 percent of the total fuel requirements of the works for 1936. Khabarovsk, Red Sormovo and many other works had reported 5,000-8,000 tons of fuel losses in evaporation and additional 3,500 to 4,000 tons of losses owing to defective fueling of the furnaces, while the installation of recuperators at the furnaces would have cost only a fraction of the value of fuel losses and would have prevented all losses.

Considerable losses are reported as caused by defective heat exchange or by improper insulation of furnace walls. Alone at the Kalinin works out of 63 furnaces only four furnaces have wall insulation.

High fuel losses are also reported from the Soviet coal mines and oil fields. At individual coal mines boilers have required about 23 percent of the total coal output of the mines for fueling purposes. The Soviet oil industry has reported almost 15 percent of the total crude production in 1936 as used in the fields and of this quantity exactly 25 percent were reported as losses which could have been prevented by proper storage, proper transportation and proper refining.

In 1936 Russian exports decreased 20.8 percent in quantity and 16.6 percent in value of returns from the previous year.

Soviet Oil Exports Jan.–Feb., 1937

	Feb., 1937 (tons)	Quantity Jan.–Feb., 1937 (tons)	Value Jan.–Feb., 1937 (Rbl.)
Crude Oil	32	40,440	1,457,000
Gasoline	36,133	71,789	7,328,000
Kerosene	26,598	51,045	3,822,000
Lube Oil	13,605	37,792	4,489,000
Gas Oil	24,412	58,148	3,168,000
Diesel Oil	1,610	2,189	75,000
Fuel Oil	76,337	138,103	4,749,000
Asphalt, Vaseline, etc.	1,021	1,022	502,000
Total	179,905	400,789	25,590,000
Total Jan.–Feb., 1936		528,048	28,860,000
England		51,897	4,812,000
Japan		49,706	2,436,000
Spain		37,444	2,498,000
Germany		34,375	2,402,000
France		27,791	1,735,000
Sweden		20,601	1,699,000
Italy		15,328	907,000
Denmark		11,155	902,000
Belgium-Luxemburg		6,257	840,000
Iran		6,247	435,000
Lithuania		5,320	368,000
Turkey		3,370	241,000
Finland		2,574	221,000
Switzerland		1,599	122,000
Afghanistan		655	141,000
Esthonia		438	35,000
Tanatuva		245	36,000
West China		461	94,000
Mongolia		410	75,000
Holland		40	19,000
Canada		25	11,000
All Others		124,898	5,550,000

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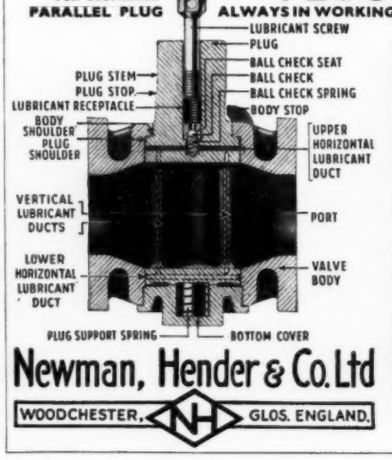

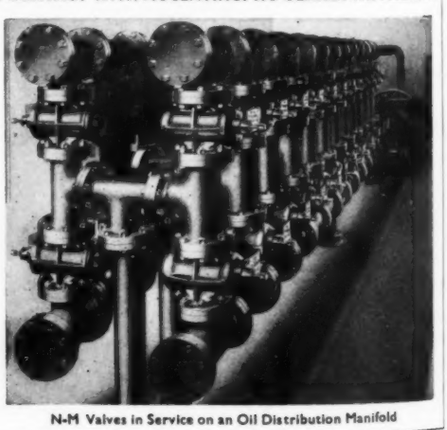

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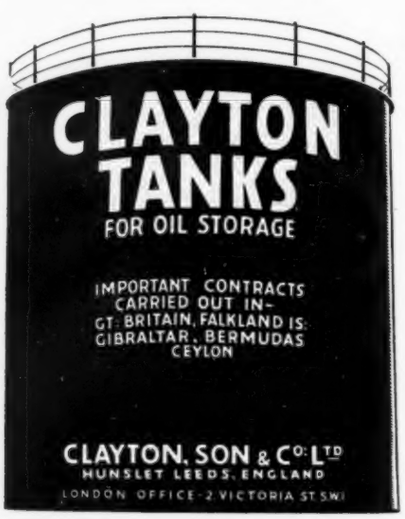


Soviet Oil Exports 1936 and 1935 by Countries

	1936	1935
France	367,003 tons	413,147 tons
Germany	347,937 tons	489,220 tons
England	272,419 tons	328,217 tons
Japan	219,898 tons	220,920 tons
Sweden	127,351 tons	148,068 tons
Italy	123,087 tons	205,438 tons
Spain	111,716 tons	178,462 tons
Belgium-Luxemburg	63,343 tons	119,262 tons
Iran	36,468 tons	32,801 tons
Turkey	22,780 tons	46,395 tons
Holland	16,577 tons	15,437 tons
Mongolia	14,379 tons	9,216 tons
All Others	930,324 tons	1,146,581 tons
Total	2,653,282 tons	3,353,764 tons
Value in Rbl.	155,550,000	186,987,000

R.O.P., Ltd., Soviet representatives of Soyusneftexport in England, is reported to have renewed several contracts with English oil importers. The contracts were to expire at the end of 1936. British imports of Soviet oil were 8,700,000 gallons in 1936 against 79,600,000 and 65,100,000 gallons in 1935 and 1934, respectively.

Soyusneftexport is reported to have signed a new contract for deliveries of gasoline to Lithuania. Total Soviet oil exports to Lithuania were about 26,000 tons as against about 14,000, tons in 1935. Gasoline is the major product of Soviet oil imports to that country. The Lithuanian cooperative Lietukis has taken over to represent Soyusneftexport in Lithuania. Being an agriculture cooperative and a newcomer to oil distribution it has now acquired five large storage tanks with several tank cars in Klaipeda (Memel) and has chartered British tanker bottoms for a period of one year to ply between Soviet Black Sea ports and the Baltic port of Klaipeda.

New contracts were also reported to have been signed for Soviet fuel oil in France. According to Soviet statistics 170,850 tons of fuel oil were delivered by Soviet Russia to France in 1936 as against 126,763 tons in 1935. Soviet fuel oil deliveries to France are mostly for the French Navy.

Oil contracts between Soviet Russia and Turkey were recently renewed. Soviet oil exports to Turkey have been:

Soviet Oil Exports to Turkey (Tons)

1932	1933	1934	1935	1936
114,484	59,099	24,815	46,395	22,780

In 1932 almost all of Turkey's oil requirements were covered by Soviet imports but in 1936 the ratio of Soviet oil imports to the total Turkish demand fell to 12 percent.

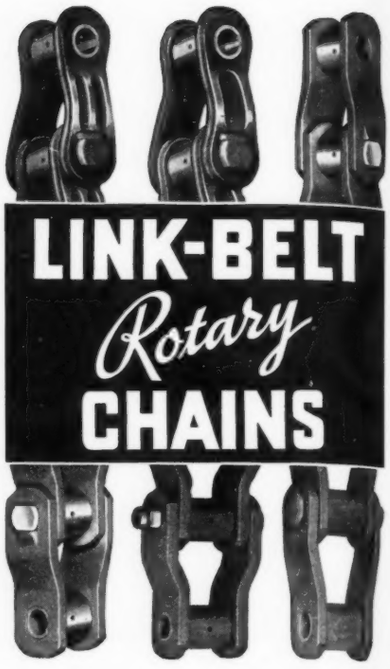
The plan for operations of the Soviet oil industry in 1937 have been revised as follows:

Revised Plan for Soviet Oil Operations, 1937

Crude production	225,120,000 bbl.
Drilling	9,240,000 ft.
New wells completed	2,100
Old wells reinstated	1,500
New cracking units on stream	8

Output of 225,120,000 bbl. compares with the previous figure of 241,500,000 bbl. Hermetization of wells and erection of new storage facilities are included in the revised plan.

J. WEGRIN



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